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HUMAN RELATIONS IN INDUSTRY

THE Committee on Human Relations in Industry was appointed in March 1953, following the disbanding in 1951 of the Human Factors Panel of the Committee of Industrial Productivity. It was appointed by the Medical Research Council and the Department of Scientific and Industrial Research, "to examine current activities concerning the study of human relations in industry and to call attention to problems of special timeliness and promise on which research, including applied research and field study, might be undertaken or supported by the Department of Scientific and Industrial Research, the Medical Research Council or other bodies". The first report of this Committee (London : H.M.S.O. 1*s*. net) covers its work for the period March 1953–March 1954, and records approval of twelve projects out of seventy-eight applications received, for which funds totalling £89,000 have been committed. Only two of these projects—Prof. O. L. Zangwill's inquiry in the Psychological Research Laboratory at the University of Cambridge and that under Prof. R. M. Titmuss in the Department of Social Science and Administration at the London School of Economics, on the employment of married women as part-time workers in a London factory—are financed by United Kingdom funds. The remaining projects are being financed by funds made available under the Conditional Aid Programme and derived from United States economic aid.

When the Committee was appointed, it was intended that a programme of research should be built up progressively over several years, and in anticipation of a wide programme of work sub-committees were set up for five broad fields of research : incentives; management organization; promotion and training ; technological change ; and special groups in industry. By critical examination of research proposals prior to discussion on the main committee, these sub-committees have permitted a much more thorough and detailed consideration of such proposals than would otherwise have been feasible in the time available. They have also facilitated informal discussions, both before and after the approval of projects, with members of research groups, and sometimes with members of organizations interested in the results of research in the human relations field. The Committee rightly believes that such direct contacts and informal discussions should contribute to the speedy application of results of research. They could also prevent the initiation of sterile projects or those unlikely to yield information which could not be better obtained by other means. Some scepticism may well be felt as to the value of a pilot research scheme into incentives for management or of a study of the flow of information in industrial organizations, with special reference to the making of decisions relating to production.

It is difficult to comment at this early stage on the value of the initial programme in the light of the information given in the present report. The examina-

tion of factors affecting the utilization of university graduates in industry, to be carried out by Political and Economic Planning with Conditional Aid Funds, may well go far beyond what university appointments boards, even when generously staffed, could be expected to do in their day-to-day activities. One part of this inquiry, for example, will endeavour to establish what proportion of arts and science graduates are entering defined sectors in industry, why they are doing so, and what use is being made of them. Another part is concerned rather with the technical colleges, and will seek to indicate ways in which the management needs of local industry can best be met by a technical college.

The one common feature of the projects thus initiated with financial assistance available through Conditional Aid Funds appears to be that the projects can be expected to show some tangible result of practical importance to productivity and industrial efficiency fairly soon, at least by the end of the Conditional Aid programme. Such a condition at once suggests the danger that the Committee's work may be planned too much with the view of short-term rather than long-term needs. Moreover, it is in precisely such conditions that there is the gravest risk of promoting projects of dubious value. Short-term needs are those of which industry itself is most aware and ready to finance itself. Further, where industry has borne no direct responsibility for the financial support of such research, it is apt to be slow in utilizing the results.

That risk may well be inherent in the financing of research in this field generally by Conditional Aid Funds; but the extent of that risk will depend somewhat on the conception of the relation between productivity and human relations in industry which guides the Committee. Wisely, the Committee has rejected any narrow approach to welfare in industry in the sense of merely improving the amenities of work. Its consideration and choice of projects has, on the contrary, been based on the broad conviction that greater satisfaction in work is both compatible with, and essential to, increased efficiency and productivity.

That conviction derives a good deal of support from the work of Elton Mayo and from the studies in management by J. F. Scott and R. P. Lynton for the British Institute of Management and by Dr. W. H. Scott, of the Department of Social Science in the University of Liverpool, on human relations in Merseyside firms; and it probably provides the justification for associating the Medical Research Council with the work of the Committee. Apart from this, the Committee has attempted to base its research programme on matters of direct concern to industrialists and trade unionists, and has taken every step to ensure that its projects have been properly discussed by the research workers with the managements and trade unions concerned. Research into the human relations problems of industry is relatively undeveloped in Britain, and there is a great need over the next few years to raise scientific standards and to improve research methods and the quality of work in this field generally from the scientific point of view. The practical value to industry of research in this field has yet to be demonstrated convincingly in Britain, and the Committee recognizes that a major and sustained effort will be needed to relate the researches to the needs of industry and to ensure that the results are applied to the maximum extent possible.

That being so, caution in the approval of projects is amply justified. The Committee itself recognizes that supply and training of research workers in this field set limits to what is practicable in the way of projects; and it indicates its intention of considering these questions and also the careers available for such workers, particularly from the point of view of combining competence in research with industrial experience. It also proposes to examine further the means of assessing research needs and of co-ordinating research projects; and on what is set forth in this report, the Committee's scrutiny and approval of research projects would appear likely to be increasingly realistic and sensible, provided only due regard is had to the danger inherent in the initiation of projects which industry could fairly be expected to undertake for itself, and to that of assuming that some formula or scientific prescription can be found which will solve any human problem in industry. No narrowing of the field within which decisions can be based on factual knowledge will eliminate the decisive importance of personal judgment.

There is, however, one broad field, in which the Committee has already approved some four projects which should repay all the study it can receive. In this field—the study of the human factors facilitating and restricting the introduction of new production techniques and methods—the project under Prof. Zangwill, being financed by United Kingdom funds, has already been mentioned. Besides this, a study, under Prof. T. S. Simey at the Department of Social Science, University of Liverpool, of technological change and social organization in industry, one of change and adaptation in industry, under Mr. T. Burns at the Social Sciences Research Centre, University of Edinburgh, and a comparative study of some production systems in mining by Dr. A. T. M. Wilson at the Tavistock Institute of Human Relations, London, have also been approved and are being supported by Conditional Aid Funds.

Human problems may readily retard or prevent changes that are necessary to enable the community or industry to reap the benefit of some technical advance, and the Committee rightly stresses the extent to which the competitive position of British industry in the world's market depends on the more rapid and effective introduction of new techniques, new materials or new methods of production. The projects already approved do not cover all the important aspects of this problem, and the Committee is well aware that many of its elements cannot be isolated. While it is endeavouring to commission research which covers both the economic and the social factors involved in the adoption of technical innovations, a joint Science and Industry Committee has been established by the Royal Society of Arts, the British Association for the Advancement of Science and the Nuffield Foundation to investigate the possibility of

speeding up the application to industry of the results of research. This Committee, which also has received a grant from Conditional Aid Funds, is to survey research already under way elsewhere in order to see what further study is needed. Its terms of reference include also the identification and assessment of those factors which determine the speed of adoption of particular technical innovations and the correlation of those factors with the characteristics of the firm or industry; the collection of evidence on the effectiveness of measures already taken to expedite the application of science in industry or to remove hindrances to such application; and examination of the possible results of other proposed measures.

It is disturbing to find that even in this field, with a single exception, the projects so far initiated depend for support upon Conditional Aid Funds. The Committee appears to recognize that this position is not sound, but its remark that over the next few years its major task will be to build around the Conditional Aid researches a balanced programme of social science research related to the needs of industry in Britain and financed from British Government funds would be more reassuring without the qualification "as and when these are made available". Even if we accept it as proper that such work of industrial importance should be financed entirely from Government funds without industrial contributions, such an attitude is too acquiescent in a position which can scarcely be regarded as wholly consistent with British self-respect. The generosity of the United States would be more fittingly acknowledged by some immediate and substantial appropriation from our own resources for research.

It is clear from the present report that the Committee is already concerned to determine the correct balance of effort between projects designed to assist the assimilation by industry of existing knowledge, short-term applied research and such fundamental studies as have just been stressed. The Committee may well require the clearly and firmly expressed support of industry and the world of science if it is to succeed in inducing the Government to make available at an early date the funds required to remove the present dependence on external resources. Meanwhile, its commendable caution in the approval of projects should keep those actually initiated well within the capacity of the trained research workers already available, and it appears that there is no intention of excessive expansion before that supply is appropriately increased. Further, the steps already taken to secure the effective co-operation, not only of research workers but also of research institutions, industry and other organizations interested in this field, should ensure that no spurious projects are promoted, but that the investigations set on foot have due regard to the limits as well as to the possibilities of a scientific approach. Attention must also be given to alternative methods which may sometimes provide a speedier, cheaper and pragmatic solution to problems in which scientific or technical factors are only two of the aspects to be considered, and judgment and personality may be the determinants.

FELLOWS OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND, 1930–51

Lives of the Fellows of the Royal College of Surgeons of England 1930–1951

By the late Sir D'Arcy Power, K.B.E., F.R.C.S., and continued by W. R. Le Fanu. Pp. xii+889. (London: Royal College of Surgeons of England, 1953.) 42*s*.

THIS work is a continuation of the two volumes entitled Plarr's "Lives of the Fellows", which were published in 1930 and constituted a biographical record of the Fellows of the Royal College of Surgeons of England who died between 1843 (when an order of Fellows of the College was established by charter) and 1930. It was proposed at the latter date to issue a supplement every ten years; but the exigencies of the Second World War and a paucity of funds led to the postponement of publication of this recent volume until now—indeed, it was only the generosity of that distinguished surgeon, the late George Grey Turner, that enabled the publication to be undertaken. Once again the remarkable bibliographic gifts of Sir D'Arcy Power were at the service of the Council, as they had been when the first two biographical volumes saw the light of day, and Power wrote for this volume the lives of all those Fellows who died between 1930 and 1940, only giving up the task on his eighty-fifth birthday, when he presented a typed copy of his work to the President and Council. By a happy chance, also, the names of W. R. Le Fanu and Samuel Wood appear in the introduction to both the 1930 and 1953 works, so that a continuity of the same high standard has been achieved. W. R. Le Fanu has himself been responsible for all the memoirs of those Fellows dying after October 31, 1940; but he has also edited the whole of the recent volume, securing uniformity of presentation without altering the text of the senior author's memoirs already in typescript.

The book is attractively produced, and he who 'reads may run' with those who have made and advanced, and those who have practised, the surgery of the first half of the nineteenth century, since many of the great surgeons of international repute have lived on into the fourth and fifth decades with which this volume deals. The notes are biographical; in the introduction, Power states that the cardinal principles of short memorials are the verification of references, accuracy and the presentation of facts, and that "from Canon Ainger, once Master of the Temple, he had learned that in this type of writing the warning often inserted in obituary notices should be strictly followed: No flowers by request". This good advice has also been scrupulously followed by the present learned and courteous librarian of the Royal College of Surgeons.

Some of the notices, especially the earlier ones, may not seem to emphasize sufficiently the transcendental operative gifts of certain surgeons; but D'Arcy Power's chief interests were never so markedly centred on the art and craftsmanship of surgery although, in fact, at the Bolingbroke Hospital he was one of the very earliest operators to resect successfully a gangrenous intussusception in an infant, while the comparative appraisal of the operative skill of various surgeons was obviously beyond the orbit of Le Fanu. I am profoundly impressed with the vast

amount of information collected by the authors about those names that figure in the text, nor is it only concerning surgeons who practised in Britain that the accuracy of the information can be vouched for from personal knowledge: the memoirs dealing with surgeons who practised in the Commonwealth countries furnish a wondrously accurate account and recall to me happy memories of lost friends.

Memory has been said to be an inspiration and incentive to those who labour in similar causes to-day: the perusal of the biographical notes in this volume cannot fail to be of profound interest and perchance inspiration to present-day surgeons and to others outside the surgical profession who find distraction in the stories of those who loyally and devotedly pursue "*Quae prosunt omnibus artes*".

GORDON GORDON-TAYLOR

DETERMINATION OF ADRENOCORTICAL STEROIDS

Memoirs of the Society for Endocrinology

No. 2: The Determination of Adrenocortical Steroids and their Metabolites. (Proceedings of a conference held by the Society for Endocrinology, at the Medical Society of London, on 21 May, 1953.) Edited by P. Eckstein and S. Zuckerman. Pp. vii+92. (London: Dennis Dobson, Ltd., 1953.) 12*s.* 6*d.* net.

THE second memoir of the Society for Endocrinology deals with factors influencing the estimation of adrenocortical steroids by means of their formaldehydogenic properties, with applications of paper chromatographic methods to adrenocortical steroid assays, with the use of sodium bismuthate to convert certain 17-hydroxycorticosteroids into 17-ketosteroids and with improved methods for the extraction of steroid conjugates from urine. In addition, the detection of a previously unidentified adrenal hormone is reported, and a study of the dehydroepiandrosterone output in adrenal virilism presented.

In the first two communications the formaldehyde-retaining properties of urinary extracts are described, a method for overcoming this obstacle to analysis introduced, and a study of the excretion of acid-labile and acid-stable formaldehydogenic steroids, as measured by this improved technique, reported.

Three of the communications are primarily devoted to methods of paper chromatographic analysis. In these the importance of tetrahydrocortisone as a metabolic product the excretion of which reflects the intensity of adrenocortical steroid metabolism is emphasized, and semi-quantitative developments of the paper chromatographic methods described. A useful account of some recent developments of technique in this field is included.

The use of sodium bismuthate in the estimation of 17-ketogenic steroids is described. This technique should prove of great value in that it avoids the large and variable losses inherent in those methods of estimation of the 17-hydroxycorticosteroids which require preliminary acid hydrolysis followed by extraction and estimation of formaldehydogenic or reducing properties. Improved methods are given for the quantitative extraction of steroid glucuronides and sulphates.

The isolation of weighable amounts of a new adrenal hormone 'electrocortin' is described in a communication which undoubtedly constitutes an important advance in the biochemistry of the adrenal cortex. This steroid has an activity some ninety times that of deoxycorticosterone. Indications of its chemical structure have already been obtained.

A method is given for the difficult estimation of 17-hydroxycorticosteroids in plasma, based upon separation on a magnesium trisilicate column and colour development with a phenylhydrazine – sulphuric acid mixture. Measurements of the output of dehydroepiandrosterone and related substances in the urine of patients suffering from adrenal virilism are reported. Such cases appear to be separable into two distinct groups upon the basis of the levels of urinary excretion of 17-ketosteroids and of substances which are chromogenic with the phenylhydrazine – sulphuric acid technique.

The discussions which follow the communications and conclude the sessions materially add to the interest of this volume, which will be valuable alike to the research worker interested in the adrenocortical steroids and to those who follow the rapid developments in this field with the view of their application to clinical problems.

N. R. LAWRIE

THEORY OF SYNTHETIC POLYMERS

Fundamental Principles of Polymerization

Rubbers, Plastics and Fibers. By Dr. G. F. D'Alelio. Pp. x+517. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 80*s.* net.

THE number of volumes on the fundamentals of polymers and polymerization is increasing rapidly. Each is usually addressed to a defined reader, for the subject is not only of purely academic interest but is also important for those who have to deal in the industrial field with plastics, rubbers and synthetic fibres. The author is well known for his practical manuals on the preparation of synthetic polymers, and this volume, being theoretical, is complementary to the other books. It is addressed to those in industry who have to deal with the more fundamental aspects of polymers, and not so much to a physical chemist interested in the development of any particular branch of physical chemistry to polymer systems themselves. The arrangement of the book is somewhat unusual; but it is in conformity with the author's intentions in regard to his potential readers.

First of all there is a very general chapter, its object being to show the place that polymers occupy in relation to other kinds of matter, and the further sub-division of high polymers into plastics, rubbers and fibres. Then follows a chapter dealing in a descriptive way with polymerization reactions in general. Rather strangely the next chapter is devoted to a discussion of the evidence for the existence of macromolecules, a matter which was of interest but is now to a large extent of historical importance only. The properties of polymers in general are treated in one long comprehensive chapter in which the structure of the polymer molecule and the behaviour of the polymer substance are discussed in close relationship to each other. Having thus dealt with matters in general, the author then proceeds in the remaining two-thirds of the volume to examine in detail the processes of polymerization. Polycondensation and

addition reactions have chapters to themselves, and logically there is a chapter on the determination of molecular weights of polymers. Much is necessarily compressed into this chapter, and the intending experimentalist would need to refer to the original works for more detailed instructions on the use of the more complicated methods. Methods of following polymerization and a detailed discussion of the kinetics of free radical and to a lesser extent of carbonium ion reactions receive their proper place in the volume. The final chapter deals in considerable detail with the phenomenon of emulsion polymerization, which is, of course, of very considerable technical importance.

As will be seen from the above remarks, the order of presentation is in a way scientifically illogical; but for those who are interested in the more applied side of polymer chemistry the arrangement is more likely to be acceptable. Polymerization is an open field for nomenclature enthusiasts, and the author brings forward a number of definitions throughout the book. About the time of publication the High Polymer Commission of the International Union of Pure and Applied Chemistry published a recommended system as a result of prolonged discussion, and it is perhaps a little unfortunate that it was not possible for the author to see this document and adopt some of the suggestions. The book was completed in May 1952; but in some of the discussions, particularly on the mechanism of polymerization, the treatment is not quite so up to date as would be expected from the date on the preface. The volume is well printed and bound. Its price is on the high side for purchasers on the eastern side of the Atlantic.

H. W. MELVILLE

BIRDS OF BURMA

The Birds of Burma

By Bertram E. Smythies. Second (revised) edition. Pp. xliii + 668 + 31 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 84*s*. net.

SEVENTY years ago, E. W. Oates published his "Birds of Burma", but the Burma of those days was restricted to that part of the country from Arakan and Pegu southwards. Shortly after the beginning of the present century the whole of Burma came under British rule, and the army officers, civilian officials and others took a great interest in birds. A new book has for a long time been needed, but it was not until a few years before the Second World War that Mr. H. C. Smith, a senior forest officer, planned the present work—or rather the original edition. Mr. J. K. Stanford undertook to prepare the letterpress, and the services of Commander A. M. Hughes, who was at that time stationed in Rangoon, were secured to draw the plates. Then the War came; Hughes and Stanford were recalled home, and though the plates were completed the manuscript was not ready. The present author, Mr. B. E. Smythies, came to the rescue, and by the year 1941 the book was published.

Owing to the War, few copies found their way out of the country, and before the end of the year the book was out of print. Shortly before orders were issued to evacuate Rangoon, Smythies rescued twenty-one of the thirty blocks for the plates and sent them to Calcutta. The original plates were saved by Mrs. Smith, but only through her sacrificing some of her personal belongings so as to keep within the 30-lb. allowance to evacuees flown out of Rangoon. When the Japanese arrived, they collected all the copies of the book they could find in Rangoon and elsewhere and sent them to Tokyo, only to be destroyed later when the building in which they were housed was struck by a bomb.

The new edition has been very considerably enlarged, re-written to a great extent, and brought up to date by Mr. Smythies when home on leave from Borneo, where he is now stationed. The climate and topography of Burma vary a great deal, and in the coastal region the annual rainfall is as much as 250 in., while in the dry zone—which covers much of the centre of the country—it may not be higher than 50 in. The author divides Burma into ten distribution areas, which are more-or-less the same as the civil divisions as shown on a map. As regards vertical zones of distribution, he defines the plains as from sea-level to 3,000 ft., the higher hills from the last elevation to 6,000 ft. and finally the mountains which in some cases go well above 7,000 ft., the highest peak being Los Long (8,771 ft.) in the Shan States. The vegetation naturally varies according to the rainfall and elevation, and all this is clearly and concisely described in the introduction.

Owing to the geographical position of the country, the birds are of exceptional interest. In the north-west there are species from the Indian region, in the east there is a Sino-Himalayan element above 5,000 ft., and farther south there is a meeting with Indo-Chinese avifauna, while in the Tenasserim peninsula many Malaysian species are found. But taking the country as a whole, the fauna is made up of Assamese birds plus indigenous species; although many species from the adjoining regions penetrate far into the interior, on the whole the avifauna seems so far to have been little affected with the development of the country. It is true that the Burmese, or green, peafowl and some of the silver pheasants have decreased, from shooting and trapping, in the more populous parts of the country. The draining and clearing of a large dismal swamp area in southern Burma to grow rice have banished the spotted-billed pelicans and adjutants which used to breed there in great numbers, and now it is not known whether they nest anywhere in Burma. Writing of the adjutant in the early eighties, Oates described how each October they visited Pegu in great armies, and on first arrival could be seen all over the flat country in groups of fifty close together. In February and March they departed. But these great numbers are a thing of the past, as Mr. Smythies tells us, and though the bird appears to be widespread it is not common in most districts.

There is a short description given of each bird which, together with the plates, should be sufficient to name most of them. There are paragraphs on habits, food, nest and eggs, status and distribution. At the end of the book there is a systematic list with parallel columns showing the distribution of each species in the ten different areas. The thirty coloured plates, with a number of species on each, are a great asset to the book, and Commander Hughes is to be congratulated.

At the present time Burma is closed to ornithologists—which is unfortunate, since so much remains to be done. However, what we do know about Burmese birds has been ably brought together by Mr. Smythies, and the present edition is a great improvement on the first.

N. B. KINNEAR

Bertrand Russell's Theories of Causation

By Erik Götlind. Pp. 164. (Uppsala: Almqvist and Wiksells Boktryckeri AB, 1952.) 16 Swedish kronor.

THIS clearly written manual is a good example of a type of composition the primary purpose of which seems to have been the clarification of the author's own mind on the complex subject of Bertrand Russell's treatment of causation. In fact, students of this theme will be grateful to Dr. Erik Götlind for committing his thoughts to print.

Dr. Götlind begins by remarking that Russell's concepts have changed periodically in consequence of the fundamental upheavals which have occurred in physics during this century. It is this 'functional' relation between the more theoretical aspects of natural science and philosophy which these pages are designed to emphasize. Thus, the plan of the book is to take Russell's major works *seriatim*, and to elucidate his view of causation as events unfold. For example, in 1912, he is still, in the main, anchored to classical mechanics, but seems to be contemplating an abstract form of action at a distance, in which acceleration is dependent upon configuration, at a given instant. By 1914, however, causal connexions can bring events into relation with one another, implying finite temporal extension, a property previously excluded. Again, it is interesting to recall Russell's reluctance to admit (in 1936) Heisenberg's principle; by 1948, much of it had been accepted.

In numerous ways such as these, we gain a valuable insight into the progress over the years of the notion of causal laws. F. I. G. Rawlins

Selected Values of Physical and Thermodynamic Properties of Hydrocarbons and Related Compounds

Comprising the Tables of the American Petroleum Institute Project 44, Extant as of December 31, 1952. By Prof. Frederick D. Rossini, Prof. Kenneth S. Pitzer, Raymond L. Arnett, Rita M. Braun and Prof. George C. Pimentel. Pp. ix+1050. (Pittsburgh: Carnegie Press, 1953.) 7 dollars.

THIS massive progeny of "A.P.I. Research Project 44", a central agency of the American Petroleum Institute concerned with "collecting, calculating, and compiling data of interest to the petroleum industry, covering physical, thermodynamic, and infra-red, ultraviolet, Raman, and mass spectral properties of hydrocarbons and all related compounds", is, as its title reveals, a bench and office reference work—"tables of data . . . of greatest usefulness to engineers as well as chemists and physicists". It may be added that appeal is both to academic and industrial spheres concerned with petroleum and allied hydrocarbons. Components of this volume were obtainable on loose-leaf data sheets as distributed, once or more each year, when ready (the bound work is issued at five-yearly intervals), and this copy embraces all material on physical and thermodynamic properties up to December 1952.

The scope comprises an introduction containing constants, conversion factors and molecular weights of hydrocarbons. This is followed by tables of physical and thermodynamic properties; specific references for tables of properties; general references; index of properties; index of compounds; and finally publications of the A.P.I. Research Project 44. This is indeed scientific reference on the big scale, and it reflects unbounded credit on the team responsible for its achievement. Even if the reader in Britain is unaccustomed to, or troubled by, the small, neat but reduced type in which the contents are displayed, he may be consoled by the fact that, had normal type been employed, this thousand-page volume would have been doubled or even trebled in size, with corresponding increase in cost. H. B. Milner

Annual Report on the Progress of Rubber Technology

Institution of the Rubber Industry. Vol. 17. Pp. xii+174. (Cambridge: Heffer and Sons, Ltd., 1954.) 21*s*.

THE annual reports on the progress of rubber technology, issued by the Institution of the Rubber Industry, have established a reputation as a comprehensive source of information on current developments in every branch of the industry. The 1953 volume follows familiar lines. There are twenty-four sections, which include, in addition to the more obvious classes of manufactured goods, the problems of the plantation industry, the physics and chemistry of rubber, synthetic rubbers, textile fibres and fabrics used in conjunction with rubber, and the use of rubber in roads. Each of the sections is written by an expert in his field and contains a large amount of information in a highly condensed form.

Those sections which deal with the more scientific aspects of the subject are perhaps the least satisfying. The separate treatment, by different authors, of the chemistry and physics of raw rubber and the chemistry and physics of vulcanized rubber reflects an archaic outlook, and might with advantage give place to sections dealing with the chemistry of rubber and with the physics of rubber. This, however, is a minor criticism of a work which on the whole is well balanced, and which provides an excellent survey of present trends of technical development in the industry. L. R. G. Treloar

Wild Flowers of the Ceylon Hills

Some Familiar Plants of the Up-country Districts. By Thomas E. T. Bond. (London: Oxford University Press, 1953.) 17*s*. 6*d*. net.

THE purpose of this little book is to enable the non-botanist to identify, with the least possible trouble, the attractive flowering plants of the hill districts of Ceylon. To this end it contains an elementary key to a hundred and twenty species, mainly based on flower colour, supplemented by sketches of the plants themselves. The sketches are extremely important, since the preliminary subdivisions based on flower colour often involve the inspection of several—in one instance, no less than eleven—sketches in order to determine the identity of the plant.

On the line drawings, therefore, will depend the success of the book. These seem to be adequate for the purpose for which they were intended. The scale of the sketch is indicated by "the average size of the flowers (generally their diameter) in inches"; but there is no indication on the drawing whether the length or the diameter is meant, and it would have been better to have shown the reduction by a simple multiplying factor. The coloured frontispiece is poor: the colours are not correct, and there is no indication of size.

The letterpress is excellent, and a great deal of information about the plant illustrated, and often of other species, is given. The book can be recommended with confidence; it will very greatly add to the pleasure of visitors to the Ceylon hills.

N. L. Bor

X-RAY STUDIES OF BIOLOGICAL MOLECULES*

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.

THE diffraction of X-rays by protein molecules has been studied in the Cavendish Laboratory, Cambridge, for the past fifteen years. The first promising diffraction pictures of hæmoglobin crystals were obtained by J. D. Bernal, I. Fankuchen and M. Perutz in 1938. Previous attempts had met with little success, and the positive results of these three workers were due to the inspiration of keeping these fragile and collapsible crystals in their mother-liquor while taking the photographs, thus avoiding their turning into an amorphous state. Except for interruptions due to the Second World War, Perutz and his colleagues have continued to follow this line of investigation, and I have collaborated in the work owing to my interest in the X-ray diffraction problems it presents. The investigation has, during recent years, been financed by the Medical Research Council, and the generous support of the project by Sir Edward Mellanby and Sir Harold Himsworth has made it possible to build up a research team of chemists, physicists, biochemists and physiologists. One main interest has continued to be the hæmoglobin molecule. It is not uncommon for a student to spend a year or more in attempting to solve the structure of a crystal which contains some atomic arrangement of particular interest, but I can recall no other instance of an attack on one type of molecule which has been continued for so long as it has in this case; and indeed, it is clear that it must be continued for many years to come if all the secrets of its structure are to be revealed. I propose to describe here the difficulties of the problem, and to indicate the exciting possibilities of a deeper insight into the structure of living matter which ultimate success would seem to promise us, possibilities which have lured research workers in the Cavendish and in other laboratories to spend so much time and thought on the X-ray diffraction by protein molecules.

Protein crystals irradiated by X-rays give very perfect diffraction photographs, with an immense wealth of character shown by the positions and intensities of the various diffracted beams. A typical photograph is shown in Fig. 1. We have for many years looked at these pictures much as archæologists must have looked at the Egyptian hieroglyphics, longing for the clue which would enable them to be read. During the past two years Perutz and I have seen some pieces of the puzzle falling into place, and fitting together into fragments of an ordered scheme. During the past six months a line of attack developed by Perutz and his collaborators has shown the relation of these fragments to each other, and has enabled the pattern to be interpreted. It has been like the discovery of the Rosetta stone with its parallel inscriptions in hieroglyphics and known languages, which provided a starting-point for interpreting the hieroglyphics. It must be emphasized at once how very partial and restricted this success is. We only have the picture of the hæmoglobin molecule as seen from one direction, and to a low power of resolution still far from showing up individual atoms. The molecules are not completely separated from each other, since they overlap somewhat in a continuous row. There is still a very long way to go before a model of the molecule can be made with all the atoms in their right places, such as can be done when advanced X-ray analysis has been successfully applied to such molecules as sugar, strychnine or penicillin.

The difficulties which X-ray analysis encounters in studying complex bodies, and the rewards which are gained in the way of a deeper understanding when it is successful must now be briefly mentioned. In the early days of crystal analysis, the structures were solved by a process of trial and error. If we postulate an arrangement of the atoms in a crystal, it is always possible to calculate how this arrangement would scatter the X-rays and to compare these calculations with what is actually observed. If the structure has been guessed correctly, the intensities of the diffracted spots can be explained. In the earliest crystals to be analysed, like sodium chloride, the positions of the atoms were fixed by symmetry. One had only to choose between one possible scheme or another quite different one, and it was in this way that the simple chess-board-like pattern of sodium chloride was found to be the only alternative compatible with the observations. But a greater complexity arose in the case of another of the early crystals to be analysed, iron pyrites. Here the sulphur atoms were in pairs, and the symmetry alone did not tell us the distance between them. This distance was a variable which could have any value and still be consistent with the symmetry. In a recent review of the progress of X-ray analysis, Prof. P. P. Ewald quoted a letter which I sent him in 1914, in which I said that I had got the structure of iron pyrites but that it was "terribly complicated". Solving it meant that one had to try all positions for the sulphur atoms and see which fitted best. It is not really hard to do this for one variable or even two or three; but the difficulties increase very rapidly when there are several variables. It is like one of those combination locks on which there are a number of rings, each with

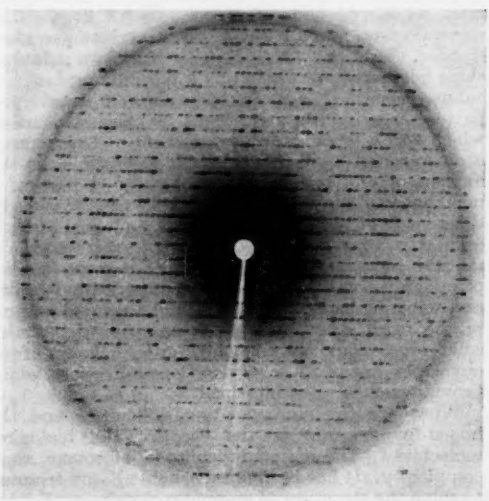

Fig. 1. X-ray diffraction photograph of a form of myoglobin (J. C. Kendrew)

* Friday evening discourse delivered at the Royal Institution on January 29.

several letters or numbers; every ring must be set at the right point before the lock will open. It would be easy to pick the lock if there were only one ring to try, or even two; but when there are half a dozen the possibilities are so numerous that the lock is proof against anyone who does not know the combination. After the First World War my research school at Manchester set itself the task of solving more complex crystals, and, when we claimed to have found the answer in cases with half a dozen variables, I still remember the scepticism with which our results were received. Our German colleagues, in particular, were very certain that one could not trust the answer when there were so many variables.

Since those days, there has been a very great advance in the art of X-ray analysis. Complicated molecules such as those of the sugars, the alkaloids, the sterols or penicillin have been analysed, although they depend on a hundred or more variables. Success in analysis is possible because guessing has become more clever, as the knowledge of the way atoms build together has increased. However, the process remains essentially one of trial and error. We try various positions for the atoms, like a burglar attempting to open a combination lock, and we know when we have picked it successfully because, generally quite suddenly, everything falls into place, and the hundreds of diffracted spots are completely explained.

What is the reward? It comes because X-ray analysis adds something of vital importance to what the chemists have already discovered about molecules. They have found what atoms enter into the composition of these molecules and in many cases which atoms are attached to which. X-ray analysis goes further in providing a working drawing or blueprint of the molecule, showing the precise position of the atoms in it, the distance between them and the angles between their bonds. It is this element of precision which is so important and gives a far deeper understanding of the physical properties of the bodies which these molecules build up, and the way the molecules can react with each other. Perhaps the most striking example of this was the analysis of the minerals which compose by far the greatest part of the earth's crust—the silicates such as asbestos, mica or felspar and, of course, quartz itself. The mineralogists who studied these substances had divided them into families with unknown relationships between their forms and a bewildering range of compositions. X-ray analysis showed a common pattern running through them all, the element of which was a tetrahedral arrangement of four oxygen atoms around a silicon atom. It is possible for the oxygen of one tetrahedron to be also a part of a neighbouring one so that the silicates can be thought of as made of tetrahedra which can be joined at their corners. Given this clue, the whole mineral world fell into place. One could see that the great families of minerals were the only ones geometrically possible and explain their precise form. The general scheme of the main substances which compose the earth's solid crust could be sketched on the back of an envelope—one of those glorious generalizations which provide such a scientific thrill.

What are the corresponding difficulties and the hoped-for rewards in the case of the biological molecules? The major difficulty is, of course, their complexity. It has been a remarkable X-ray triumph to solve the structure of organic molecules containing some fifty atoms; the molecule of hæmoglobin contains ten thousand. Nature would seem to need molecules of this vast complexity to do the very specialized tasks of living matter. Further, in the case of a sugar or a sterol, one can make a good guess from the start as to what it should look like, basing it on the findings of the chemists and on previous experience with similar molecules. In the case of a protein molecule we are still very largely in the dark. The chemists have told us something about its structure, but its organization is a complete mystery. To attack by X-ray analysis structures which have this complexity of quite a different order is therefore a venture into a new field. Trial and error methods are hopeless, as any burglar would agree, faced with a combination lock with ten thousand rings on it. New techniques must be found. The reward to be hoped for if the search for the structure is successful is, of course, a greater understanding of the properties and behaviour of these molecules. By analogy with the far simpler silicates, we may be able to see why the geometrical demands of the kinds of arrangements permitted to the atoms make the method which Nature has employed the only one which could have effected her purpose in a living body.

The chemists have told us something about these strange bodies which build up living matter. I have called them strange because the way they are built seems at first sight to be so arbitrary, and it is hard to see why Nature should have been forced to use this particular way to achieve her object. The most important constituents are protein and nucleic acid in their various forms.

There are two ways in which one might picture a mechanic building a complex part of a machine which had to perform some very special function. He might take his raw material and fashion it on the lathe and milling machine to some very precise design, to interact in exactly the right way with other components; most mechanisms are of this kind. There is, however, another example of the designer's art which has become of immense importance recently, namely, the arrangement of condensers, inductances and resistances to be found in any radio or other electronic circuit. Here the components are all simple standard pieces, and the art lies in 'composing' them or putting them in the right relation to each other. The complexity in this case lies not in the precise fashioning of a single unit, but in the complex relationship of a number of simple units. It is this second way which Nature has chosen in building living matter.

Proteins are built by joining together in long strings quite simple chemical units, the amino-acids. One half of each amino-acid has always the same plan. This end has, as it were, a chemical hook and eye (that is, acid and basic group), so that the hook can be joined to the eye of its neighbour on its right and the eye to the hook of its neighbour on its left. The other half determines its character, being a small tag of a few atoms of a kind peculiar to that particular amino-acid. There are somewhat more than twenty different kinds of tag. One may compare them to the letters of the alphabet used by the printer, each being a small piece of metal of identical shape at one end, so that it fits into his forme, and with the letter stamped on the other end. In making a protein, Nature works like the printer, joining these letters in a special order to form words and sentences. Just as books of every kind are written with the same letters, so protein of all kinds is composed of these same twenty amino-acids; their special

function, it would seem, is due not to some very special kind of complex molecule, but to the order in which these molecules are arranged along the 'polypeptide chain'.

Nucleic acids are also long chains of relatively simple units, the nucleotides. The unit appears to be a very strange one to have been chosen for the particular functions of nucleic acids in the body, which seems to be the determination of the character of the living matter and its handing on from one generation to the next. If the proteins are the machines which do the body's work, nucleic acids appear to be the machine tools used in fashioning them. The common part of each unit is a sugar with a phosphate group attached to it. The character-giving tag is either a six-fold ring or a six-fold ring joined to a five-fold ring, termed a pyrimidine or purine. Broadly speaking, there are only four kinds of these, and it would seem that they always join up in two specific kinds of pair. So, in fact, there are only two kinds of tag in contrast to the twenty-odd amino-acids. We might say that the message of the protein is like one conveyed in writing, whereas the message of the nucleic acid is written in the dot and dash of a Morse code.

I will now indicate in very general terms the way in which it has been found possible to interpret the diffraction pictures given by hæmoglobin. The hæmoglobin crystals have the type of symmetry which is termed monoclinic. They have a two-fold axis of symmetry, so that looking along this axis every element of structure on one side has its counterpart in an equal and opposite direction on the other. We have so far only considered the projection on a plane perpendicular to this axis, that is to say, what we would see if we were looking at the molecule in the direction of the axis. The symmetry is of great assistance in solving the problem.

When X-rays fall on the crystal and a photographic plate receives the diffracted beams, they appear as a complex pattern of spots of different intensities. In dealing with a projection as in this case, the problem is formally analogous to the action of a cross-grating, a regular pattern in two dimensions, which is diffracting monochromatic light. The units of the pattern scatter the incident rays, and the scattered waves build up into wave trains which form the spots. Having recorded these wave trains on the photographic plate, we must somehow try to interpret them and see what kind of pattern produces them. To understand how this is done in a very general way, imagine that we have made an animated cartoon of the process, a rapid succession of drawings of the waves falling on the pattern and being scattered. We should see the incident rays coming along, circular ripples being scattered by each atom, and these ripples combining together to form trains of waves going off in the directions of the different spots. Now imagine that, as we are projecting this animated cartoon, we throw over the lever of the instrument which makes the film run backwards. The trains of waves would start back from the spots, run towards the pattern and there, in a magical way, we would see them combine to turn into little spherical waves, collapsing on the places where the atoms are. So by starting the waves backwards we should see the projected pattern of the crystal by noting the points at which these waves collapse. This must be so because it is always possible to picture a reversal of the light beams in a diffraction problem.

Though, of course, we do not make animated cartoons, this corresponds to what is done in X-ray analysis. We measure the diffraction waves and then calculate mathematically how they would combine if produced backwards into the crystal where they originated.

There is, however, one major difficulty inherent in this process. To make the waves run backwards and reveal the crystal structure, we must know both their amplitudes and phases. The amplitude can be measured because the intensity of each spot is proportional to its square. But we must also start the waves backwards so that their crests and troughs arrive at the atoms at the right relative times, so that they interlace together to reveal the structure. This is expressed scientifically by saying that we must know the phases of the waves, and these phases cannot be measured experimentally. The problem is greatly simplified in the present case because for 'phases' we can simply say 'plus or minus'. This is so because of the symmetry which I have mentioned above. Since the structure is symmetrical about the two-fold axis, the waves which reveal it must be symmetrical; they must make standing waves with either their crests or their troughs at the places of the two-fold axis. So when we look at all the diffracted spots of hæmoglobin, we could solve the structure if we could label each of them with a plus or minus sign. It might at first sight seem easy to try different combinations of plus and minus signs for the spots. There are, however, some hundreds of them, and the number of combinations represented by 2^{100} (about 10^{30}) is very large indeed.

Two technical advances have made it feasible to determine these signs without uncertainty. One is possible owing to a very remarkable property of the hæmoglobin crystal. It can be made to swell and shrink like a concertina, while still remaining a perfect crystal, by altering the constitution of the liquid by which it is surrounded. When it swells, all the diffracted spots appear at smaller angles, and vice versa. Any given diffracted spot may be a 'plus' spot for one crystalline form, and then, as the concertina opens, it may dwindle away to zero and change into a 'minus' spot, because it represents a scattering by the molecule in a series of different directions. So by mapping out the strength of the spots for different stages of expansion and contraction, we can map out regions of alternative sign in the map which represents the way in which the hæmoglobin molecule scatters in different directions. We do not know whether any given one of them is plus or minus, but we can see whether they change from one sign to the other.

The last step has quite recently been made by Perutz. He has found it possible to attach two mercury atoms to the hæmoglobin molecule without altering the crystal structure. Now the way these two mercury atoms scatter is a very simple affair; they produce the well-known diffraction fringes, and it can be told at once whether they are giving a plus or minus contribution in any given direction. If in a place where the mercury gives a plus contribution, it is found that its addition increases the scattering, the hæmoglobin scattering must be plus too. If it decreases, then the hæmoglobin must have been minus. So by noting the differences made by the mercury, Perutz has been able to attach the right signs all over the diffraction picture, reducing the number of possibilities, 2^{100}, to one.

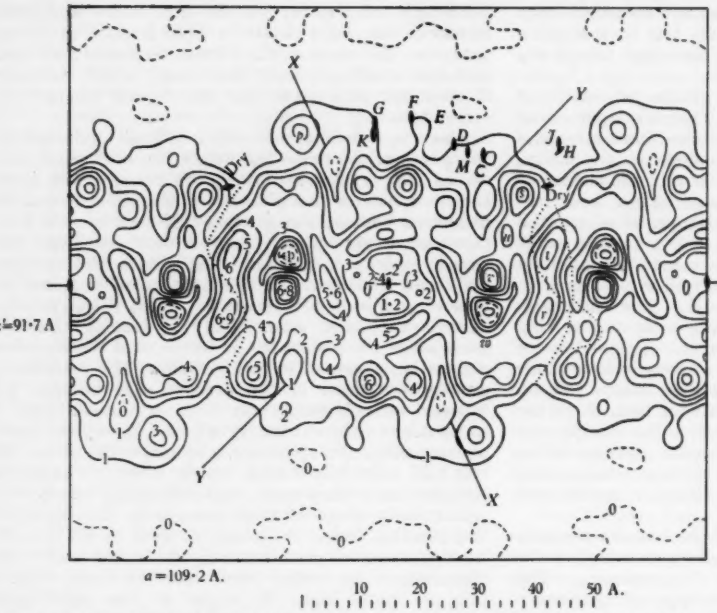

Fig. 2. Projection of a hæmoglobin molecule with two overlapping molecules to right and left. The density is represented by contours. Points where neighbouring molecules in the crystals touch are marked *G*, *F*, *E*, etc.

The rest of the solution follows at once. Knowing these signs, one puts together the waves with the right phase relation, and a picture of the hæmoglobin structure is the result. A picture of this kind is shown in Fig. 2. The masses of scattering matter in the molecules are shown in the way hills and valleys are shown on a map, by drawing contour lines through points of equal density. It will be seen how very incomplete and hard to interpret the results are as yet in this first picture of a protein molecule. In the first place, the resolution, in the sense that this term is used to describe the degree of detail of an image seen in the microscope, is still very low. The inner spots of the diffraction pattern are due to the broader grouping of masses in the molecule, whereas the outer spots arise from the finer details. In the present case only the inner spots have been used, and so the molecule is seen as a kind of diffuse picture with the atoms smoothed out so that they cannot be separated from each other. Now that the secret of analysis has been found, there would appear to be no difficulty in the way of using all the spots in the picture and getting much more detail. In the second place, though the wide variation of the *c* spacing makes it possible to sort the atoms apart in that direction, the crystal does not expand or contract along the *a* direction, which is horizontal in Fig. 2. The molecules overlap to a certain extent along the chain, and so it is impossible to see exactly where one stops and the next starts. Only one crystal has so far been found where the *a* direction shrinks slightly, making it possible to get a hint about the dividing line between the molecules where they overlap. I have not attempted to give here a picture of the separated molecules, because the drawing of the dividing line is still so conjectural.

The structure of nucleic acid should be mentioned in passing, because it illustrates so well one of the main points I have referred to above. Nucleic acid is not crystalline, but by suitable manipulation the long chains can be coaxed into a semi-crystalline form in which they are approximately parallel. Very fine photographs of a form of nucleic acid (deoxyribonucleic acid), prepared by Dr. M. F. Wilkins, have been obtained in Prof. J. T. Randall's laboratory at King's College, London. Quite recently, an X-ray interpretation of this nucleic acid chain was put forward by J. D. Watson and F. H. C. Crick, the correctness of which is strongly supported by the available evidence. The chains are double, the structure being like a spiral ladder with the sides formed by alternate sugar and phosphate groups and the rungs each composed of a purine hydrogen-bonded to a pyrimidine. The special point made by Watson and Crick, to which I should like to refer here, is the peculiar relation of the two kinds of pair, or tag, already mentioned. The two bonds where a rung is linked to a sugar at either end come out at exactly the same positions for either pair turned either way round. It is as if this pair which makes the rung of the ladder were a small bit of 'Meccano' which always just fitted in whichever way round it went. Now it appears highly probable that Nature writes the story of the gene, the hereditary element in the nucleus, by arranging these two pairs in some kind of order along the chain, like a Morse message in dot and dash. For this it is essential that either a dot or a dash may be a rung of the ladder. Is there not perhaps a hint here that Nature had to use phosphate groups, sugar, purines and pyrimidines, because nothing else would do to satisfy such rigid geometrical requirements?

The main point I wish to make, therefore, is that success in analysing biological molecules by X-rays may explain to us why they have the structure they have. To make a comparison once more with the mineral world, we see that silicon and oxygen together build very stable structures which are light and have a high melting point, and that is why most of the earth's crust is made of silicon and oxygen. Their tetrahedral frameworks conveniently accommodate certain other metal elements, and correspondingly it is found that these rank next to silicon and oxygen in order of frequency of occurrence in the rocks. On the other hand, carbon, nitrogen and oxygen, together with hydrogen, build structures which are relatively unstable, but which are capable of an infinite complexity. This is so because the atoms are fastened together by bonds which have definite positions. Hence Nature has used these elements to make the complex structures of living matter. Now, as in the case of the silicates, we shall perhaps be able to see further into the reason for the arrangements of these elements which Nature actually uses. If in due course we make a voyage to Mars by a

rocket-ship, we can confidently predict that mineralogy will be very much the same on Mars as it is on this globe of ours. If we find life there, however, the plants and animals would undoubtedly be of quite a different kind; there is no reason to think they will have developed in a parallel way to ours. But it is quite likely that these strange creatures will be built of protein and nucleic acid, with just the same amino-acids, purines and pyrimidines as Nature has found essential for her purposes here. At any rate, H. G. Wells thought so, for his "The War of the Worlds" gives a ghastly description of the invading Martians capturing and feeding upon the inhabitants of this planet, and how humanity was saved because the Martians succumbed to the bacteria from the attacks of which we had become immune. The Martian could not have assimilated his prey nor fallen a victim to the bacteria unless he were built up of the same proteins as all living matter on this globe. With a prophetic insight Wells appears to have realized that the strange and wonderful way in which we are made is not a matter of chance but is a result of the nature of matter itself.

INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION

THE ninth international conference of the International Committee for Bird Preservation was held at Scanfs, Ober-Engadin, Switzerland, during May 23–26, and was attended by representatives of the following national sections: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Great Britain, Iceland, India, Italy, Japan, the Netherlands, Norway, Sweden, Switzerland, the Union of South Africa, the United States of America and Venezuela, together with representatives of the Conseil International de la Chasse and the International Union for the Protection of Nature, and observers from the Irish Republic and Luxembourg.

One of the most important subjects dealt with was the prevention of the pollution of the sea by waste oil, in which the International Committee for Bird Preservation has taken a leading part for many years. The results of the international conference convened by the British Government during April 26–May 12, with the details of the international convention agreed at that conference, were reported, and the fact that (up to May 18) eleven countries had signed the convention, subject to acceptance, was noted with satisfaction. Proposals for immediate action in order to secure the implementation of the recommendations of the London conference and to secure further information for the future conference envisaged were discussed. It was agreed that the support of all other interested organizations and individuals (such as fisheries, pleasure resorts and hotels, yachting clubs as well as animal and nature organizations) should be secured, and that governments be urged to sign and ratify the convention, to carry out so far as possible the resolutions attached to the convention, and to secure the effective enforcement of the requirements by adequate penalties and supervision. In addition, it was agreed that the keeping of a careful record of the extent of oil pollution on the coasts should be organized, especially with regard to the effectiveness or ineffectiveness of zones, and to promote scientific research on the effect of oil pollution on all marine life, more particularly in respect of fish and plankton, not only in the vicinity of the coasts but also in the ocean, and research on the persistence of the different oils. It was also agreed: to carry out active propaganda to keep the subject of oil pollution before the general public and governments; to give strong support to the recommendation that a further conference be held to review the working of the new arrangements within three years, and that efforts should be made to ensure the inclusion of at least one biologist in each delegation; and to propose to countries concerned with whaling fleets that investigation should be promoted with regard to antarctic conditions, and the possibilities of avoiding discharge of oil by these fleets should be explored.

The representatives of the European national sections present reported on the situation with regard to the ratification by their respective governments of the International Convention for the Protection of Birds, Paris, 1950. Austria, the German Federal Republic, Iceland, the Netherlands and Switzerland stated that their governments were preparing to ratify the convention either in the near future or in the coming year, and at the end of the conference a telegram was received notifying that the Netherlands Ambassador in Paris had ratified the convention on behalf of that country. The representatives of the British Section were in the unhappy position of having to report that there was little chance of their country ratifying the convention, despite the high hopes that had been entertained when the joint proposals for new legislation left the hands of the Wild Birds Advisory Committees to the Home Office and Home Department for Scotland, the main difficulty being the refusal to follow the general trend of modern bird preservation in according the same protection to eggs as to the birds themselves.

Birds which are a menace to other species is an important question, and an international subcommittee to consider the situation with regard to the herring gull (*Larus argentatus*) in the countries bordering the North Sea was set up at the last world conference of the Committee held in Sweden in 1950. The reports of members of this sub-committee were submitted, in which detailed records of breeding colonies of these birds over a number of years were included. Opinions regarding the effect of this bird on other species were widely divergent, representatives from Germany and Holland strongly maintaining that in many places herring gulls were far too numerous and caused great destruction to other species, whereas the Danish ornithologists took the opposite view. Various methods which had been used in controlling the numbers of these birds were discussed, and finally the following resolution was agreed: "The Herring Gull (*Larus argentatus*) has increased, with the aid of disturbances in the balance of nature due to human interference, and in some countries, has, in certain areas, caused a diminution in the breeding populations of other sea-birds. This is only one of a number of biological factors involved, but it seems desirable to obtain the most accurate possible information about the status of the Herring Gull through an annual investigation of breeding pairs and of young reared in the North Sea south of the Skagerrak and the Firth of Forth and in the western Baltic Area. National Sections are invited to arrange such censuses, so far as practicable,

according to circumstances in particular countries and to transmit the results of their censuses annually to the I.C.B.P.".

The preservation of wildfowl was dealt with from various aspects, beginning with a report of the work of the International Wildfowl Research Institute (in future to be known as the International Wildfowl Research Bureau), and detailed reports from the organizers of the national counts of wildfowl in Germany, Great Britain, the Netherlands, Sweden and Switzerland. Methods of wildfowl investigations and conservation in the United States were explained, and an account of the work being carried out in Australia was given, followed by more specialized papers such as that on the waterfowl of the Venetian lagoon by Dr. L. Leporati and a review of the situation of the brent goose (*Branta bernicla*) by Dr. Finn Salomonsen, of Denmark. Dr. Salomonsen spoke of the serious decrease in numbers of brent geese and the urgent need for measures to protect this bird, as the species is in danger of extinction. His remarks were supported by speakers from other countries, and finally a resolution was adopted urging the governments concerned to recognize that the brent goose at present be regarded as in danger of extinction, and recommending governments controlling its wintering and breeding areas as well as its migration routes to give it complete year-round protection as an emergency measure, to remain in force unless and until it becomes clear beyond possibility of doubt that the future existence of the brent goose is assured. It was further agreed that the International Committee for Bird Preservation should initiate a detailed international investigation into the status of the European brent goose.

The effect of international trade in plumage, cage birds and carcasses of game birds on the populations of the species involved was dealt with at length. The Venezuelan representative spoke of the difficulties being experienced by his country in preventing the export of feathers of egrets, which though prohibited is continuing illegally, to meet the demand of dealers in Europe. The delegates from India referred to the serious depredations in recent years on the grey jungle fowl (*Gallus sonnerati*) on account of the demand for its hackle feathers; though the bird is protected in India its feathers are being obtained by other countries. In order to assist in preventing the illegal export of birds' feathers from countries where they are protected, and Venezuela and India in particular, it was agreed that the European Organization for Economic Co-operation (O.E.E.C.) in Paris should be urged to remove from the list of merchandise the importation of which member countries have not the right to prohibit, feathers of birds protected in their country of origin, in particular birds of paradise and egrets (the feathers of domesticated birds not included). It was further agreed to recommend that all governments, especially that of the United States of America (where the greatest importation takes place) be urged to prohibit the import of feathers of the grey jungle fowl (*Gallus sonnerati*) from all ports in the Indian sub-continent, since the habitat of this species is peninsular India only, and the species has suffered serious depredation in recent years.

The Australian National Section put forward a resolution regarding the prohibition of the exploitation of live birds in view of the great increase in the exports of wild-caught birds from Australia, which is at present computed to be more than five times that in the years immediately preceding the Second World War, and in 1951–52 was estimated at 48,000 birds. A slightly amended resolution was adopted which recommended that governments of all countries be requested to restrict the export and import trade in wild-caught birds, and only to permit the export of rare and protected species in small numbers to zoos and *bona fide* aviculturists for scientific study and breeding.

The establishment of a series of reserves on migratory routes of birds, initiated at the meeting in Sweden in 1950, was reported upon and maps indicating the position of the reserves were supplied by various national sections.

On the proposal of the German National Section, a resolution was adopted calling for full protection of the white stork in those countries through which these birds migrate in autumn and spring, and on the request of the Danish representatives the black stork was included in this proposal. The need for the better protection of birds of prey was discussed, and the undue destruction of these birds was reported in particular by representatives from France and the Union of South Africa. The importance of birds of prey and the widespread misunderstanding of their value was generally agreed and a resolution adopted as follows: "The Conference learns with regret of the continuing indiscriminate destruction of birds of prey in many parts of the world. This is in conflict with modern biological knowledge regarding the essential part taken by birds of prey in maintaining natural balance of populations. The destruction of birds of prey in general is shortsighted and should be brought to an end, but it is realized that in some exceptional cases properly supervised control measures are sometimes necessary. The Conference recognizes the value of much of the legislation that has recently been enacted and commends the efforts of various governments to enforce such measures. The Conference urges that such measures should be further developed and fully enforced and that educational campaigns be initiated to inform the public of the biological importance of birds of prey". National sections were requested to make suitable representations to their governments to ensure that action is taken in each country in accordance with particular requirements.

Other subjects dealt with were species in danger of extinction. Representatives of various national sections spoke of their concern regarding their native species, among others mentioned being the great Indian bustard and the Australian bustard. The mass destruction of the red-billed weaver (*Quelea quelea*) in French West Africa and the Quaker parrakeet (*Myiopsitta monacha*) in the Argentine by means of fire was discussed; while appreciating that these birds have become pests in these countries, a resolution was passed advocating other less drastic methods of controlling them, and recommending that further investigations be made into the amount of harm caused by their depredations of crops. A report on the International Conference for the Protection of the Fauna and Flora of Africa held in Bukavu in October 1953 was given by Dr. Boje Benzon (Denmark), who had attended the meeting as an observer for the International Committee for Bird Preservation, and representatives of national sections presented reports on the bird preservation situation in their respective countries and on any new legislation that had been introduced.

THE PILTDOWN BONES AND 'IMPLEMENTS'

At a meeting of the Geological Society on June 30, there was again a series of exhibits concerning the bones, teeth and artefacts obtained from Piltdown. This was the third occasion of its kind within nine months. It may be presumed that it will be the last; for the Piltdown objects have lately been reinvestigated in such detail, by so many specialists using so many techniques, that there can scarcely be factual profit from further work upon them.

It is agreed that the skull fragments are human and not of great antiquity; that the jawbone is ape; that they have no important evolutionary significance. More than five hundred articles and memoirs are said to have been written about Piltdown man. His rise and fall are a salutary example of human motives, mischief and mistake.

The first exhibit at the meeting on June 30 was by Mr. A. T. Marston, who has long maintained that the Piltdown mandible and canine tooth are ape, and unrelated to the skull fragments; but who opposes the claim that the jaw and tooth have been deliberately faked. Mr. Marston showed a modern chimpanzee mandible which he had stained with potassium dichromate. It was yellow, in contrast with the chocolate-brown of the Piltdown jaw. He said that he had tried without success to reproduce the Piltdown colour by treating many modern bones with iron salts and chromate. He also contended, illustrating his remarks by specimens, that all the essential characters of wear on the Piltdown teeth are reproduced when articulated casts of orang jaws and teeth, mounted in an appliance to give ape jaw-movements, are 'ground-in' with carborundum paste; that the facet on the upper canine becomes concave from above downwards and spreads to the anterior border; that flatness comparable with that of the Piltdown molars is produced in the molars of the cast; and that the angles of wear on the molars of the cast and the original are identical.

Sir Gavin de Beer, director of the British Museum (Natural History), then introduced a series of exhibits and speakers on work which indicates, in sum, that the Piltdown finds represent a most elaborate and deliberate hoax, and that not one of them came genuinely from Piltdown. He summarized the methods which had been used, and pointed out that they would not only make a successful repetition of a similar style of forgery virtually impossible, but also would be of future value in palæontological research. Sir Gavin emphasized that the author of the Piltdown hoax remains unknown.

Prof. W. E. Le Gros Clark said that the molars in the Piltdown jaw differed from those of a modern large ape in only two significant features—the flat wear of the occlusal surfaces, and the shortness of the roots as seen in X-ray photographs published in 1913. New X-ray photographs had shown that the roots are in fact much longer, and quite similar to those of modern apes. The artificial character of the abrasion of the molars was demonstrated, *inter alia*, by the facts that the dentine on the antero-internal cusp is flat and flush with the enamel; that more dentine has been exposed on the antero-internal than on the antero-external cusps, the reverse of natural wear; that there is no bevel on the margins of the occlusal surfaces and the central talonid basin; that there is lack of conformity between the surface contours of the two molars; and that there are fine criss-cross scratches on them, apparently produced by an abrasive. The canine is evidently a young tooth, yet the whole thickness of the enamel has been removed from the inner surface crown. An X-ray photograph showed that its pulp-cavity had been opened near the apex and plugged with some plastic substance. Lastly, a re-study of the fragments of the so-called 'turbinal bone' showed that they are in fact fragments of a small limb-bone of some animal.

Dr. J. S. Weiner showed that by grinding and polishing the first and second molars of an orang, occlusal surfaces extremely like those of the Piltdown molars, with similar dentine pattern, can be produced; and that the height of the crowns is then almost identical. The chin region of an orang jaw, broken as in the Piltdown mandible, compares closely with the latter in all characters including the simian shelf. After abrading an orang upper canine to the state of the Piltdown canine, it had been easy to insert sand-grains from Piltdown into the pulp-cavity. Dr. Weiner remarked that the Piltdown canine contains very little of the fine sand or silt which one would expect natural infiltration of sediment to introduce.

An exhibit by Mr. S. H. U. Bowie and Dr. C. F. Davidson dealt with the implication of radiometric assays. Dr. Davidson said that during an investigation of the radioactivity of phosphate rock a few years ago, it was found that fossil bones and teeth often have a noteworthy radioactivity, apparently acquired from percolating ground-waters, and with a quantitative relation, taking account of variants of environment, to geological age. He exhibited a tabular statement of the ranges of radioactivity of a large number of bones from sands and gravels of various ages, and another showing the radioactivity of the Piltdown and Swanscombe primate bones. The Swanscombe measurement, 27(eU_3O_8 in p.p.m.), falls within the Middle Pleistocene range. The Piltdown primate fragments all have extremely low radioactivity: 3(eU_3O_8 in p.p.m.) for the left parieto-frontal I; 2, for the occipital I; 1, for the temporal fragment; and all others less than 1. It is possible that the feeble radioactivity of the chromium-bearing left parieto-frontal, and perhaps of other fragments, is due to the presence of the potassium isotope ^{40}K. From these assays, Dr. Davidson said, it appears that the '*Eoanthropus*' remains are Holocene rather than Pleistocene. Dr. Davidson showed that measurements on the other Piltdown vertebrate remains give a remarkably wide range of radioactivity. The three molars of *Elephas* cf. *planifrons* are all far more radioactive than any other British mammalian bones of Tertiary or later age which have been studied; and in an examination of similar *E.* cf. *planifrons* teeth from foreign localities, the same high order of radioactivity is found only once, in a specimen from Ichkeul, Tunisia. On the other hand, the two 'Piltdown' hippopotamus teeth, and some of the beaver bones, are less radioactive than any other Tertiary or Pleistocene fossils which have been examined from any British or foreign source. It seems certain that the bones of the Piltdown 'assemblage' had very different geological and geochemical histories.

Dr. G. F. Claringbull and Dr. M. H. Hey reported on mineralogical and chemical tests. Drillings from the Piltdown cranium were found, on examination by X-ray diffraction, to be mixtures of apatite and

gypsum. Gypsum was later found in many other Piltdown specimens. Gravel and loam from the site, and ground-water nearby, were analysed by Dr. R. C. Hoather and Dr. C. Bloomfield and found notably low in sulphate content. But gypsum had also been found in a skull from Barcombe Mill in the C. Dawson Collection in the British Museum (Natural History); and in matrix adhering to this skull there were calcium and ammonium sulphates—though these were not present in freshly collected samples of matrix from Barcombe Mill. It had been thought possible that the gypsum arose from reaction during soaking of the bones in an iron salt to produce staining, and experiments were therefore made on white bone from a neolithic skull. A solution of iron alum even as weak as 2½ per cent produced a fairly full-brown colour accompanied by conversion of the apatite of the skull to gypsum. With ferrous sulphate solution the reaction was less, but there was some replacement of apatite by gypsum. No natural conditions (except perhaps close proximity of a sulphide ore-body undergoing active weathering) could be postulated to produce the same effect. It therefore seemed that the gypsum in the Piltdown specimens was in fact an incidental effect due to artificial treatment by iron solutions in order to produce brown staining.

Dr. K. P. Oakley was the last speaker. He said that other tests had confirmed that the Piltdown mandible is entirely recent. In addition to the nitrogen test, its organic content had been found to be the same as that of fresh bone; and by means of the electron microscope, Prof. J. T. Randall and Dr. A. V. W. Martin had shown that intact collagen fibres occur in decalcified samples of the mandible, whereas none could be detected in the calvaria. Dr. A. E. Werner and Miss R. J. Plesters, of the National Gallery, had reported that the black coating on the canine tooth is a paint of bituminous earth pigment, probably vandyke brown. Dr. Oakley said that the work of Drs. Claringbull and Hey indicates that both the Piltdown skulls I and II are fraudulent; and their composition shows that, unlike the mandible, they are sub-fossil though post-Pleistocene. There is a further complication: the right frontal of Piltdown II could anatomically, from its unusual thickness and histology, have originally been part of Piltdown I. Since analyses have shown that their fluorine/phosphate ratios are in agreement, it could be inferred that these right frontal fragments did belong to Piltdown I, and not to the thinner occipital fragments said to have been found with them. All the Piltdown flints figured as palæoliths, he said, show evidence of artificial iron-staining. Dr. A. E. Moss has estimated that the stain on the flint *E* 606 contains *c.* 0·1 mgm. chromium per sq. cm. A chip from the cortex of this flint showed that the staining is superficial, with pure white cortex beneath. Dr. Oakley said that the worked elephant bone is certainly fossil, but experiments have demonstrated that it could not have been whittled to its shape while it was a fresh bone, and he showed a fossil bone from the Swanscombe gravel carved with a steel knife to reproduce all the features of the Piltdown implement. From the chemical and other evidence it was judged that the Piltdown bones and teeth had been assembled from a wide variety of sources and that some of them were foreign. The low nitrogen and low fluorine content of the hippopotamus molar can be matched only by material from cave deposits, for example, in Malta [see also p. 65].

OBITUARIES

Prof. J. B. Buxton

Prof. James Basil Buxton, principal and dean of the Royal Veterinary College, died suddenly in his office at the Field Station, Streatley, Berks, on May 25. His death is a severe loss to the veterinary profession in Great Britain, of which he had been a leading figure for many years.

Born in 1888, the son of a veterinary surgeon, he graduated at the Royal Veterinary College in 1919 and, after studying in the University of Liverpool, was for a short time lecturer in hygiene at the Royal (Dick) Veterinary College, Edinburgh.

In 1912 he became the first veterinary superintendent of the Wellcome Physiological Research Laboratories under the directorship of Dr. H. H. (now Sir Henry) Dale, an appointment which afforded him ample scope for development and a congenial atmosphere for work. He there laid the foundations of a department which is noted for its achievements in the field of veterinary research and the control of animal diseases.

In 1922 Buxton joined the scientific staff of the Medical Research Council and was in charge of the Farm Laboratories at Mill Hill, where he organized the investigation into dog distemper which the Council undertook with the aid of *The Field* Distemper Fund. He designed the buildings in which to breed a supply of fully susceptible dogs for experimental use, and drew up the programme of work which was largely followed by Laidlaw and Dunkin in their classical studies on the disease. It was the successful outcome of this project which paved the way to the subsequent work on human influenza.

In 1923 Buxton was appointed to the newly created chair of animal pathology at Cambridge and became responsible for planning and staffing the Institute of that name then about to be established. Within a few years he built up an organization known throughout the world as a centre of research and a training ground for research workers from home and overseas. Among the studies on which he himself was engaged during this period special mention may be made of those on the double intradermal tuberculin test, the standardization of tuberculin and the value of B.C.G. vaccine as an immunizing agent against tuberculosis in cattle.

In 1936 he was elected to succeed Sir Frederick Hobday as principal of the Royal Veterinary College, and under him the College has made great progress as the result of improved staffing and organization. He deserves much credit for the skilful way in which he organized its work in most difficult circumstances when it was evacuated from London during the Second World War, and for the part he afterwards played in its being accepted as a School of the University of London.

Prof. Buxton had a long record of distinguished service to the National Veterinary Medical (now British Veterinary) Association and the Royal College of Veterinary Surgeons and was a past-president of both bodies. For some time he was chairman of the Examinations Committee of the Royal College, and it was largely through his initiative that the course of study leading to the M.R.C.V.S. diploma was extended in 1932 from four to five years.

His name will always be associated with the organization and development of veterinary research

and education in Great Britain, in which he has played an outstanding part and thereby made a lasting contribution to the well-being of agriculture.

T. J. Bosworth

Commander J. Hennessy, M.B.E.

The sudden death, in his sixty-ninth year, on May 22 of Commander J. Hennessy, deputy marine superintendent of the Meteorological Office, is announced with regret. Commander Hennessy had been deputy marine superintendent of the Meteorological Office since 1919; but during the Second World War he was in sole charge of the Marine Branch of that Office, in the absence of the Marine Superintendent on active service.

Hennessy played an important part in the reorganization of the fleet of voluntary observing ships after the First World War. This was afterwards developed, in 1930, into the 'Selected Ship' system, whereby weather reports are received by radio from merchant ships all over the world at selected meteorological centres. This forms a modern development of the scheme introduced by Maury in 1855 for the collection of weather information from merchant ships.

Commander Hennessy played a considerable part in organizing the statistical treatment of marine meteorological data. In 1921 the Hollerith punched card system was adopted in the Marine Branch in order to facilitate analysis of the enormous amount of data in ships' meteorological logs which had accumulated and which had previously been laboriously extracted by hand. There is little doubt that without the aid of such a system the compilation of world-wide climatological statistics for all oceans and the resultant preparation of comprehensive marine meteorological atlases which was carried out during the War under Hennessy's direction—in consultation with the Admiralty—would have been an almost impossible task. Since the data used for these atlases covered as long a period as 1855–1939, account had to be taken of the frequent, but unavoidable, changes in international meteorological procedure and codes. The resulting atlases are probably the most accurate and comprehensive of their type in existence.

Among the other work with which Commander Hennessy was closely associated, the preparation of atlases showing the surface currents of the oceans, compiled also from ships' observations, and of atlases giving the distribution of sea ice may be mentioned. He also took a large share of the responsibility for fitting up the British and Norwegian ocean weather ships and the subsequent administration of the former.

Hennessy was a member of the Commission for Maritime Meteorology of the World Meteorological Organization. He was made M.B.E. in the New Year Honours for 1953.

Commander Hennessy not only possessed a square-rigged master's certificate but also had sailed as first mate in a sailing ship—the barque *Miniven*. He later served in steamships and was in command of the Northwest Transport Company's *Uranium*. During the First World War, as a lieutenant R.N.R., he served aboard the armed merchant cruiser *Carmania* and was present during her famous battle with the German *Cap Trafalgar*. He also took part in the Dardanelles landings, aboard H.M.S. *Hussar*, and was later in command of that ship.

Commander Hennessy will be much missed by his many friends in the meteorological world and in shipping circles. He had a very likeable personality; his outstanding characteristics were loyalty and devotion to duty and a fine sense of humour. He is survived by a widow and two sons.

C. Frankcom

Prof. F. London

Fritz London, who died on March 30 at the age of fifty-four years, belonged to those theoretical physicists who in the years between 1920 and 1930 began their first investigations under the guidance of Sommerfeld, and soon were able to make contributions of very great importance. In these years only a very few posts were available for theoretical physicists, and like several others, he aimed at first at a different profession. He took his Ph.D. in Munich in 1921 with a paper on philosophy and started to prepare himself for a teaching career. However, the attraction of theoretical physics overwhelmed his sober plans. His first paper appeared in 1925 (jointly with H. Hönl) and deals with the rules for the intensities of band spectra. Investigations of this type preceded the development of modern quantum mechanics which essentially was completed in 1927. In this year London met W. Heitler in Zurich, where they wrote their classic paper on the homopolar chemical bond. It led to the interpretation of chemical valence in terms of electronic spin and has remained the basic paper on which a vast amount of work by both physicists and chemists has been built. Further developments led to the theory of activation energy in chemical reactions; another important step was the recognition that the tetravalency of carbon is not due to its ground state but to an excited state. Investigation to a higher degree of accuracy of the forces between atoms led in 1930 (in a joint paper with Eisenschitz) to a quantitative understanding of the long-range forces known as van der Waals attraction.

London had spent the years 1928–33 in Berlin where he was *Privatdozent* at the University. In 1933 he went to the Clarendon Laboratory in Oxford and became interested in the old problem of superconductivity. His brother Heinz had just advanced interesting new ideas on this subject, and jointly they found a phenomenological description of the electromagnetic properties of superconductors known now as the London equations. It is on this subject that London has published several monographs which greatly stimulated both theoretical and experimental research.

In 1936 London went to the University of Paris as Maître (later as Directeur) de Recherche, and in 1939 at the beginning of the war to the United States as professor of theoretical (later of physical) chemistry at Duke University. In these years he again extended the subject of his previous interest. Superconductivity had attracted his attention to the high diamagnetism of certain molecules, on one side, and to the superfluidity of liquid helium on the other. In both subjects he found novel points of view linking up with his previous investigations on the structure of matter.

In 1948 he learned that he was suffering of a dangerous heart disease. Thanks to the devotion of his wife, this did not lead to a flagging of his activity and he continued with all his previous fervour in his investigations. The course of London's life was inevitably influenced by the political upheavals of the last few decades; but he moved through all these changes himself unchanged.

H. Fröhlich

NEWS and VIEWS

Chemistry at University College, London : Prof. H. Terrey

Prof. H. Terrey retires from a University chair of chemistry tenable at University College, London, at the end of September. He will remain associated with University College and the Department of Chemistry there for a further period under the College title of special lecturer, thus continuing a connexion which began so long ago as 1912 (see *Nature*, May 10, 1952, p. 778).

Prof. R. S. Nyholm

Prof. R. S. Nyholm, of the Technical University of New South Wales, Sydney, has been appointed to succeed Prof. Terrey. He is expected to arrive to take up his new duties in the spring of 1955. Prof. Nyholm is a graduate of the University of Sydney. He was appointed an I.C.I. Research Fellow, and afterwards a lecturer, in the Chemistry Department of University College, London, in which he will now serve in his new, senior, capacity. He is distinguished mainly for his extensive and important work on both the structural and physical aspects of co-ordination chemistry.

Division of Animal Health and Production, C.S.I.R.O., Australia : D. L. B. Bull, C.B.E.

Dr. L. B. Bull, the most senior chief of division of the Commonwealth Scientific and Industrial Research Organization, Australia, has retired from his post as chief of the Division of Animal Health and Production, after twenty years service with the Organization. He has been succeeded by Mr. D. A. Gill, formerly an assistant chief of the Division and officer-in-charge of the McMaster Animal Health Laboratory, Sydney (see *Nature*, June 12, p. 1123). Dr. Bull, who is sixty-five, was born in Auburn, Victoria, and graduated B.V.Sc. at the University of Melbourne in 1911, gaining his D.V.Sc. eight years later. He was appointed deputy chief of the then C.S.I.R. Division of Animal Health, and became chief in the following year. Under his guidance, the Division has become the most extensive of the Organization's establishments, with a total staff of 320 distributed among five main laboratories and eight field stations in different parts of Australia. His advice has been widely sought on the application of scientific method to investigations of problems of national importance, and he was appointed a member of the Australian National Research Council in 1932. He was elected an honorary member of the Section of Comparative Medicine of the Royal Society of Medicine in 1945, and was awarded the diploma of honorary fellowship of the Royal College of Veterinary Surgeons in 1951. He was made a C.B.E. in 1952.

In spite of the heavy administrative burden entailed in Divisional duties, Dr. Bull has continued his personal research work and in recent years has played a leading part in the study of such problems as mastitis in cattle, and copper metabolism in sheep and liver pathology in domestic animals generally. The spectacular success achieved in Australia since 1951 in the control of the rabbit through the agency of the virus disease myxomatosis is in no small measure due to his pioneering research on this problem during 1934–42. He was able to demonstrate not only the difficulties which stood in the way of the spread of the disease by transmission from rabbit to rabbit, but also the possibilities of transmission by means of insect vectors such as various species of Australian mosquitoes and the stick-fast flea. Dr. Bull will not be severing his connexion with the Organization, for he has accepted a senior research fellowship and will be continuing his researches in the field of animal pathology with particular reference to the liver.

United Kingdom Atomic Energy Authority

The following have been appointed members of the United Kingdom Atomic Energy Authority, which takes over the control of atomic energy developments in Great Britain on August 1 : Sir Edwin Plowden (chairman), formerly chief planning officer and chairman of the Economic Planning Board ; Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell ; Sir Christopher Hinton, deputy controller of atomic energy (production), Ministry of Supply ; Sir William Penney, director of the Atomic Weapons Research Establishment, Aldermaston ; Sir Donald Perrott, chairman of the Interdepartmental Committee on Woolwich Arsenal ; Lord Cherwell, professor of experimental philosophy in the University of Oxford ; Sir Luke Fawcett, general secretary of the Amalgamated Union of Building Trade Workers ; and Mr. I. A. R. Stedeford, chairman and managing director of Tube Investments, Ltd. One other member remains to be appointed.

George Eastman (1854–1932)

George Eastman, one of the great pioneers of modern photography, was born in the village of Waterville, New York, on July 12, 1854, and in honour of the hundredth anniversary of his birth a postage stamp bearing his portrait is being issued by the United States Postmaster-General as one of the "Famous American" series. In addition, the Royal Photographic Society will be holding a commemoration exhibition at 16 Princes Gate, London, S.W.7, during August. At the age of fourteen, poverty forced Eastman to leave school and get a job as a messenger boy at 3 dollars a week. He first became interested in photography at the age of twenty-three and, after mastering the clumsy wet-plate process then in general use, turned his attention to the newly invented gelatine dry plate. In 1879 he received a patent for a plate-coating machine, and in the following year began to manufacture dry plates for sale. Within a very few years he substituted for glass his perfected system of roll film photography, and in 1888 brought out a greatly simplified camera which he called the 'Kodak'. With Eastman's box camera the amateur photographer merely pressed a button ; the finishing of the pictures was done in the factory. In 1889 Eastman produced flexible transparent film, and this was utilized by Thomas Edison to make cinematographic pictures. Eastman created a great photographic industry, which to-day as the world-wide Kodak organization has factories and experimental centres in Britain, the United States, Australia, Canada, France and Germany ; photographic products of all sorts and descriptions are manufactured. Eastman was also a pioneer in the field of industrial relations and a great philanthropist. In the early years of his firm, when he had earned a substantial amount of money, he made a personal gift to his employees, and later he instituted a wage dividend plan by which each employee shared

in the firm's earnings. In 1919 he gave one-third of his own holdings of company stock, then worth ten million dollars, to his employees, and later he established the retirement annuity, life assurance and disability benefit plan for his workers. He gave dental clinics to London, Paris, Rome, Brussels and Stockholm, and large sums of money to educational institutions, so that in all he gave away more than one hundred million dollars.

The Piltdown Bones and 'Implements'

In view of the recent meeting of the Geological Society (p. 61 of this issue), a communication by Prof. M. F. Ashley Montagu, of the Department of Anthropology, Rutgers University (*Science*, **119**, 884; June 18, 1954), in which he poses some pertinent questions, is of interest. He examined the original Piltdown bones in 1951, and now questions the presence of portions of a turbinate, since he cannot recall any instance in the annals of palæoanthropology of this extremely fragile bone ever having been recovered in a fossil hominid. He continues: "If it does naturally belong with the Piltdown bones, then it may be regarded as casting considerable doubt upon the antiquity of the Piltdown skull. . . ." After questioning other points, hitherto accepted as authentic, Prof. Ashley Montagu refers to the 'bone implement', saying: "It is highly probable that when this alleged 'bone implement' is carefully studied it will be found that the terminal facets were produced by a sharp metal blade probably of the Sheffield steel variety; in short, that this 'bone implement' is quite as much a fake as the mandible".

Registration of Chemists and Engineers in the United States

The United States National Science Foundation is to compile a National Register of Scientific and Technical Personnel, and recently it has received two grants for the registration of chemists and engineers, with which it is possible to make a start on the work. The registration of chemists will be undertaken by the American Chemical Society, Washington, D.C., and the Society is sending out questionnaires to an initial list of fifty thousand American chemists. In all, it is expected that information will be obtained from approximately sixty-five thousand chemists, and the details will be kept up to date by the Society. The registration information on each individual will include name, address, education, chemical specialty and current employment. Duplicate copies will be sent to the Foundation for statistical studies and to assist in the mobilization of scientists in time of war. The information will not be used normally for finding posts for, or placing scientists. The registration of engineers will be conducted by the Engineers Joint Council, New York. At present, no attempt will be made to obtain registration information on all the estimated half a million engineers in the United States, but this section of the Register will be limited to about twenty thousand leaders in all engineering fields. The selection will be based on "Who's Who in Engineering" and other sources. The list will be maintained up to date by the Engineers Joint Council.

At the present time ten professional societies or associations are collecting registration information for the Register, the estimated numbers of scientific workers who will be listed being as shown: American Institute of Biological Sciences, 40,000; Federation of American Societies for Experimental Biology, 10,000; American Veterinary Medical Association, 14,000; American Geological Institute, 18,000; American Psychological Association, 11,000; American Institute of Physics, 15,000; American Meteorological Society, 10,000; American Mathematical Society, 12,000; American Chemical Society, 65,000; and Engineers Joint Council, 20,000. The National Science Foundation expects the initial registration of all these classes of scientific workers to be completed by June 1955. Inevitably, some workers are classified in more than one field; but, although there is a danger of duplication of names owing to the decentralized manner in which the registration is being carried out, this is being avoided by liaison between the various bodies, and in the preliminary consolidation of the individual lists it is hoped to be able to eliminate most of the duplications.

The Botanical Survey of India

A scheme for the reorganization of the Botanical Survey of India has recently been approved by the Government of India. The main features of the scheme are: (1) The division of India into a number of regional groups based on phyto-geographic affinities, each under a regional botanist, who will be responsible for the survey of that region. The regional groups will be designated as north, south, east and west, with their headquarters at Dehra Dun or Lucknow, Madras, Calcutta and Poona, respectively. (2) Establishment of a central directorate under an officer who will be designated as the chief botanist, for co-ordinating the activities of the various regional groups and for implementing the policy laid down by Government. (3) The creation of a central botanical laboratory under a director at a suitable place in India, where the living plant will be studied in relation to its biology and its utility to the nation. (4) The maintenance of a Central National Herbarium which will house the 'type specimens' and a fully representative collection of the plants comprising the flora of India. (5) Maintenance of a botanical museum on modern lines in Calcutta.

All existing facilities in the country will be utilized to the fullest in the reorganized Botanical Survey. Collaboration with the universities and research institutions will be encouraged by making grants to staff and research students to conduct research on problems dealing with the flora of India, and for collecting material for the long overdue revision of Hooker's "Flora of India". Inclusion of university students in Botanical Survey explorations and the imparting of practical instructions in collecting and preserving of specimens is also envisaged. The Botanical Survey will search for new economic plants in the unexplored regions of India. The introduction of plants from outside India will also be the function of the reorganized Survey. The director of the Central Botanical Laboratory has been already appointed. She is Dr. E. K. Janaki Amal, who has graduated in the United States, worked at the John Innes Horticultural Institute, London, during the War, and spent several years in the Wisley Gardens of the Royal Horticultural Society.

Two Meteorites Found in Australia

The curator of the Western Australian Museum (Beaufort Street, Perth), L. Glauert, reports that two unusually large meteorites have been acquired by the Museum. Mr. E. C. Johnson, whose farm is about twenty miles south-east of Quairading, has presented what is as yet the largest known fragment of the

Youndegin meteorite (see Simpson, E. S., *Min. Mag.*, **25**, 166; 1938), weighing 5,789 lb.; the other meteorite, which weighs 1,057 lb., has been given to the Museum by H. E. and A. G. Carlisle, and was found twenty miles from Rawlinna, on the Trans-Australian Railway crossing the Nullarbor Plain. Although their exact classification has not yet been determined, both are iron–nickel meteorites (siderites).

The Abbey House Museum, Leeds

In 1925 the Corporation of Leeds purchased the Abbey House, and under the direction of the Committee of the City Museums it has been transformed into an interesting museum. A guide, price 6*d*., to the collections has been issued. The guide is well illustrated and clearly indicates how the objects as now arranged are illustrative of the life and work of the people of the region from the Stone Ages in general and from the twelfth century in particular. The costume display is peculiarly effective in that it is supplemented by the Eleanor Williams series of costume dolls, which on account of the accuracy of their dress portrays vividly the fashions and foibles of our ancestors.

Museum of South Australia: Annual Report for 1952–53

The annual report for 1952–53 of the Board of the Museum of South Australia, Adelaide (pp. 12. Adelaide: Government Printer, 1954), directs attention to the fact that there has never been adequate funds to carry out field-work. This is all the more important on account of the great increase of agricultural and other activities and the consequent rapid decrease of the native fauna and flora. For example, during recent years the widespread laying from aeroplanes of baits for wild dogs has had a profound effect on the small marsupials. Notwithstanding the lack of finance, it is interesting to note that a grant of £A.300 enabled a reconnaissance trip to be made to Lake Callabonna to collect specimens of *Diprotodon*. As a result, this important genus is now represented by additional material, including a complete adult, a juvenile skeleton less pelvis and tip of tail, and two large skulls. A detailed report on this material is awaited with interest.

Training in Taxidermy

It is announced in the April number of the *Museums Journal* that arrangements have been made by the British Museum (Natural History) and the Royal Scottish Museum for training to be given in taxidermy to members of museum staffs as a preliminary to the examination for the Museum Association's Technical Certificate. Candidates, who must be on the staff of a museum, will be selected by the Education Committee and given training for a period of three months in one of the two institutions. In exceptional circumstances financial assistance may be considered. Applications should be sent to the Secretary of the Museums Association, Meteorological Buildings, Exhibition Road, London, S.W.7.

Floristic Studies

Systematic studies of the flora of tropical America by the Chicago Natural History Museum have been taken a stage further by the publication of another section of "Contributions to the Flora of Venezuela" (*Fieldiana*: Botany, **28**, No. 3, 449–678, with line drawings, 1953; 4.25 dollars). This is the work of J. A. Steyermark and collaborators and deals with the orders "Ericaceae through Compositae". A floristic study of a somewhat different kind is that by H. Santapau on "The Flora of Khandala on the Western Ghats of India" (*Rec. Bot. Surv. India*, **16**, No. 1, 1953; price Rs. 32 or 49*s*., from Manager of Publications, Delhi). This aims at being a complete Flora (flowering plants only), based on an intensive study of a small but interesting region situated on the western edge of the Deccan Plateau, some 116 km. from Bombay. In an introductory essay the general features of the region are described and matters of special ecological interest discussed. "The Vegetation of Jamaica", by G. F. Asprey and R. G. Robbins (reprinted from *Ecol. Monogr.*, **23**, 359; 1953), is a study of plant geography and ecology of an island of special botanical interest. The general features of the island are briefly outlined, and the floristic features are then analysed and discussed under the headings of phytogeography and the varied formations and communities comprised in the flora. This monograph is illustrated by some good photographs, maps and vegetation profile diagrams. The authors conclude that the present vegetation of Jamaica enables a reasonably accurate reconstruction of the original vegetation to be made. They consider that the early descriptions of the island as being covered in dense jungles, with extensive lowland tropical rain forest, are not borne out by this survey.

Discovery

The June 1954 issue of *Discovery* retains the high standard which has been set by its editor, W. Dick, during the past ten years. Dr. W. E. Swinton contributes an imaginative but well-authenticated article on the possible flight mechanisms of pterodactyls which is admirably illustrated by some original line drawings. S. Rogerson links up the prehistory of Brandon in Suffolk with the 'knapping' or chipping of flint stones which is still carried on to-day, complete with a vocabulary which reveals its ancient origins. Britain's false-scorpions are the subject of an article by T. H. Savory, who describes not only their structure, habitat and behaviour but also ways of keeping and feeding them. Horticulturists should appreciate Dr. Kenneth Smith's account of the virus diseases which cause colour breaks in flowers as well as Dr. G. Haskell's description of the history and genetics of the raspberry. Another article deals with the early scientific work on platinum which was done in Spain some time before W. H. Wollaston produced malleable platinum around about 1805. The air correspondent to the journal discusses the atom bomb's effect on airplane design, while short leading articles deal with such varied topics as the future of British sociology, 'hibernation' in operating theatres, coal pumping and myxomatosis.

Earthquakes during March

During March there were some thirty-four strong earthquakes in the world, ten of which had magnitude 6 or greater, and three of these latter had magnitude 7¼. On March 1, at 3.40 a.m. local time, an earthquake was felt over an area in Australia of some seventy thousand square miles from Kangaroo Island to Melrose, near Adelaide; there was some property damage, but no casualties. On March 11 tremors of unknown origin were felt in Bridlington and adjacent places on the east coast of Yorkshire, which caused cracks in plaster, doubtful disturbances being observed on seismograms at the University of

Durham Observatory at 11h. 37m. 59s. and 11h. 38m. 38s., G.M.T. On March 29 one of the earthquakes of magnitude 7¼ occurred in the Sierra Nevada in the south of Spain. Extensive minor property damage occurred over a very wide area, but the maximum felt intensity was only about 4 on the Modified Mercalli scale. The shock was recorded at Edinburgh at 06h. 21m. 04s., G.M.T., and over a very wide area. More than a hundred observatories sent seismogram readings to Strasbourg, where the initial time of the earthquake was evaluated as at 16h. 17m. 09s., G.M.T., and the epicentre at lat. 37° N., long. 3¼° W. From the facts already mentioned, from arrival times at the various observatories, and from the observations that surface waves, if present, had extremely small amplitudes, it is considered that this earthquake had a very great depth of focus (600–650 km.). This is most unusual, since earthquakes with such great depths of focus have only previously been known from foci near the Pacific Ocean; none has previously been found in Europe since adequate instrumental recording began (say fifty years ago). The other shocks with magnitude 7¼ occurred on March 3 with an epicentre in Central New Guinea and on March 31 with an epicentre in the Arabian Sea; the only other shock with deep focus (550 km.) occurred in the Fiji Island region on March 6. Apart from the above, five of the thirty-four earthquakes were experienced in Europe.

Peaceful Uses of Atomic Energy

More than seven hundred scientists, working on the peaceful uses of atomic energy in thirty different countries, are to meet at Oxford during July 19–22 to discuss advances made in the past three years. They are to attend a conference organized by the Atomic Energy Research Establishment, Harwell, on isotope techniques. Developments in medical research and treatment, in industrial processes and in agricultural research will be discussed. Britain has become the leading exporter of isotopes to Europe, the Commonwealth and other countries outside the United States. Most of the materials come from Harwell; but at the Radiochemical Centre, Amersham, the work of a team of chemists specializing in the production of chemical compounds incorporating isotopes has been arousing world-wide interest. Orders at these two centres are now being dealt with at the rate of 15,000 a year, of which more than 5,000 are to other countries. In the past six years radioactive isotopes have been sent to forty-two different countries from the United Kingdom. The conference will be opened by Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell. The sessions will be private, but further information can be obtained from the Secretary, Atomic Energy Research Establishment, Harwell, Nr. Didcot.

Royal Meteorological Society: Officers for 1954–55

The following have been elected officers of the Royal Meteorological Society for the year 1954–55: *President*, Dr. O. G. Sutton; *Vice-Presidents*, Prof. P. R. Crowe, Sir Charles Normand, C. D. Ovey and Prof. P. A. Sheppard; *Vice-President for Canada*, F. W. Benum; *Vice-President for Scotland*, Dr. A. E. M. Geddes; *Treasurer*, Dr. J. S. Farquharson; *Secretaries*, Dr. H. L. Penman, Dr. G. D. Robinson (librarian), R. G. Veryard and Dr. T. W. Wormell (editor).

Announcements

The following elections have been made in the Paris Academy of Sciences: M. André Couder, director of the Paris Section of the Service des Mouvements Progrès Stellaires, to be a member of the Astronomy Section, in succession to the late Prof. E. Esclangon; Prof. J. Kampé de Feriet, professor of fluid mechanics in the University of Lille, to be a *correspondant* for the Mechanics Section in succession to Prof. L. Escande, recently elected a non-resident member of the Section.

Mr. R. D. Edge, of the Cavendish Laboratory, Cambridge, has been appointed a Research Fellow in the School of Physical Sciences of the Australian National University, Canberra. He will work with Prof. E. W. Titterton on the 30-MeV. electron synchrotron which will shortly be erected in the Department of Nuclear Physics. This machine, which was in use at the Atomic Energy Research Establishment, Harwell, until recently, was given by the U.K. Government to the Australian Government for installation in Canberra.

Dr. Charles Kemball, demonstrator in physical chemistry in the University of Cambridge, has been appointed to the chair of physical and inorganic chemistry in The Queen's University of Belfast. The following have been made lecturers in the University: V. C. R. Ford (geography), J. Drewery (psychology), Dr. W. Schwarzacher (geology).

The thirty-third annual general meeting of Fellows of the National Institute of Agricultural Botany will be held at Cambridge on July 16; Sir John Russell is to address the meeting.

The Universities Federation for Animal Welfare will be holding a summer school, open to both members and non-members of the Association, at Knuston Hall, Northamptonshire, during September 18–25. The programme will include expeditions to the Animal Health Trust Research Station at Huntingdon and to an artificial insemination centre and to Cambridge, as well as lectures, discussions and social activities. A fee of 5 guineas, which will include full board and all the expeditions, will be charged (3 guineas for students). Application and all other communications should be sent to the local branch secretary of the Association or to Miss M. Williams, UFAW, 7*a* Lamb's Conduit Passage, London, W.C.1.

The Electrical Engineering Department of the Imperial College of Science and Technology, London, will hold a five-day vacation school on aircraft electrical systems during September 20–24. The course is designed for a maximum of sixty engineers who already have some experience in the design and application of aircraft electrical power equipment, the object being to bring out, partly by lectures and partly by mutual discussion, the scientific principles underlying the design and application of all types of equipment. The fee for the course (including lunches, refreshments, transport, etc.) will be eight guineas. Hostel accommodation is available. Further information can be obtained from B. Adkins, Department of Electrical Engineering, Imperial College of Science and Technology, London, S.W.10.

RADIO TELESCOPE AT JODRELL BANK EXPERIMENTAL STATION, UNIVERSITY OF MANCHESTER

ON June 10, representatives of the Press and others assembled at the Jodrell Bank Experimental Station of the University of Manchester to inspect the progress on the erection of the radio telescope. The reasons for building the telescope, which is sponsored jointly by the Department of Scientific and Industrial Research and the Nuffield Foundation, were explained by Prof. A. C. B. Lovell, and the engineering consultant, Mr. H. C. Husband of Sheffield, described some of the engineering problems. The essential feature of the telescope is a 250-ft. diameter steel bowl, paraboloidal in shape, 62·5 ft. deep at the focus. This is to be covered with a reflecting screen of 1 inch square mesh. This main bowl, weighing 600 tons, will be carried on two towers so as to pivot on a horizontal axis 180 ft. above ground. The drive for the elevation movement will be by 100-h.p. metadyne motors through 27-ft. tracks which were originally in the battleship *Royal Sovereign*. The two towers are each mounted on six bogies which move on a circular railway track. The bases of the towers are connected by a cross girder to the central pivot. The azimuth motion is obtained by an electrical drive from four of the bogies.

The foundations were completed by the end of 1953. They consist of a concrete ring supported on reinforced piles sunk to the keuper marl (in places up to 90 ft. below ground-level), which carries the 17-ft. gauge double railway track of diameter 350 ft. This railway track, which has to carry a superstructure weighing 1,500 tons, is level to $\frac{1}{8}$ inch, and in order to provide the necessary stability nearly 5,000 tons of steel and concrete have been used in the foundations. The central pivot, which is already in position, is carried on similar deep foundations. A sample of the twelve bogies on which the main steel framework is to be carried was also available for inspection. At the time of the visit, a 120-ft. crane mounted on 60-ft. gabbards was erecting the first of the main 15-ton 120-ft. jib cranes on 120-ft. gabbards, two of which are required to erect the telescope itself. The erection of the steelwork is expected to begin this month and to be largely complete by the end of the year. It is anticipated that the radio telescope will be finished in 1955.

The radio telescope was also discussed by Prof. Lovell in a Friday evening discourse at the Royal Institution on May 21. The need for such a large instrument arose from the desire to obtain high power gain and directivity in the investigation of the radio waves from space. In this the requirements are analogous to those of conventional telescopes. The significant advances in the study of the universe have been made through the medium of large telescopes. Successive increases in aperture, culminating in the great 200-in. on Mt. Palomar, have given more resolving power and more light-gathering power, thereby enabling more distant regions of the universe to be explored. The analogy in radio astronomy is very close; but since the wave-lengths are a million times longer than light, the radio telescopes have to be of far greater size than their optical counterparts. Prof. Lovell described how the new radio telescope would be used for investigating the extra-terrestrial sources of radio noise, or radio stars, so few of which have so far been identified with visible objects. Demonstrations were also given of the use of the radio telescope in the study of meteors, the moon, and of the complex relationships between events on the sun and the disturbances in the earth's ionosphere.

METHODS OF LAND-CLEARANCE FOR AGRICULTURE

ON April 20 a meeting arranged by the Agriculture Group of the Society of Chemical Industry was held at the Royal College of Science, London, to discuss the large-scale clearing of forests. Unfortunately, three out of the five speakers named on the programme were unavoidably absent; the subject-matter of two papers, however (those of R. H. Gunn and A. McBride), was incorporated by Dr. A. H. Bunting, of Tozi Research Farm, Singa, Sudan, into a joint paper entitled "A Review of Methods of Land Clearing".

Dr. Bunting began by pointing out that in many regions of the world land-clearing has always been a fundamental component of agricultural systems and is an integral part of the system of shifting cultivation still widely employed by primitive communities who grow their crops on patches where the bush or forest has first been cut down or burnt. In many tropical areas the nutrient status of the soil is so low that, under the existing conditions of management, only one or two crops can be taken from the cleared area, which is then abandoned and soon becomes covered by vegetation consisting in the main of regrowth from the roots and stumps of the cut woody plants. It is accepted that burning of the cut vegetation before cultivation gives rise to increased yields. The nutrient value of the ash is probably only one of several factors involved. Dr. Bunting stressed the need for further analysis of the function of bush fallow in restoring productivity. Recent work in the Sudan suggests that a type of erosion described as 'surface wash' of the exposed soil may be one reason for the rapid decline in productivity of tropical soils after the bush canopy has been removed. Under these conditions, the top few inches of the soil which may contain the bulk of the accumulated fertility can be washed away.

Modern methods of farming often demand a different type of clearing, involving the complete and large-scale removal of stumps and roots of the existing trees and bushes. Such large-scale clearance schemes are likely to include the following phases: survey of the area by aerial photography and ground observations, followed by the preparation of detailed soil and vegetation maps; production of a land utilization and conservation policy and construction of access roads and labour camps; cutting of the vegetation; disposal of debris; removal and disposal of stumps; and installation of soil conservation works.

An informative analysis was given of the different methods of bush-clearing employed in the Groundnut Scheme in Tanganyika, together with the costs of each operation. Much of the heavy equipment, particularly that used for the removal of roots, caused severe damage to the soil, and the current view is that lighter implements should be used wherever possible. Dr. Bunting concluded by saying that it is not generally appreciated how much detailed information on the bush-clearing techniques had been obtained in Tanganyika and that this information would be of great value in the planning and execution of clearing projects.

The second paper, entitled "The Present Role of Arboricides in Bush and Forest Clearance", was given by Mr. J. D. Fryer, of the Agricultural Research Council Unit of Experimental Agronomy, University of Oxford. The paper was in two parts. The first section reviewed the development of chemicals for killing individual trees or scrub either by individual treatment or by overall spray application. The second part summarized some work on arboricides carried out in Tanganyika and Kenya by members of the Unit of Experimental Agronomy working in conjunction with various organizations in East Africa.

Of the many chemicals that have been tested, arsenical compounds have proved to be by far the most successful, and they are at the present time widely employed in forestry and plantation work for the local treatment—in frill girdles, bark notches or auger holes—of unwanted trees. There is, however, a definite need for non-poisonous substitutes, and much work has been done during the past ten years in an attempt to find materials that are both efficient and safe. The most promising is undoubtedly ammonium sulphamate; but the synthetic growth regulators 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) have also given good results when applied in the same way as arsenical compounds, particularly with smaller trees. These phenoxyacetic acids also show promise when applied in an oil carrier to the bark of the trunk as a basal band of one or two feet. This treatment in effect 'girdles' the stem by killing the bast and cambium and may also destroy dormant buds, thus preventing or reducing regeneration.

During the past few years considerable advances have taken place in the destruction of bush or scrub by arboricides. Extensive areas of scrub along roadsides, under power and telegraph lines and in grassland are being sprayed each year in the United States and Canada with good results; this practice is being developed in other countries, particularly New Zealand. The chemical most commonly used for this work is 2,4,5-trichlorophenoxyacetic acid, generally as a long-chain ester, applied either alone or mixed with 2 : 4-dichlorophenoxyacetic acid. For overall applications from the ground, oil/water emulsions are often applied in a relatively high volume per unit area; but when application is made by aircraft more concentrated oil solutions or emulsions are employed. Ammonium sulphamate in an aqueous solution is also being widely used as an overall application from the ground.

The investigations in East Africa have been mainly of two types: the development of arboricides for the control of regenerating bush of the types found in tsetse-fly barrier clearings in Tanganyika, or for the destruction of *Isoberlinia-Brachystegia* bush in Nyasaland, which is characteristic of large areas where shifting cultivation is practised by the natives; and secondly, the testing and assessment of the value of chemicals as defoliants of woodland as an aid to tsetse-fly control. The results to date of spraying regenerating bush indicate that a complete kill is unlikely to be obtained with the existing arboricides because they are not transported in toxic quantities to the roots and because the species which are adapted to frequent cutting and firing sucker freely from the roots. The overall spraying by aircraft of the butyl ester of 2,4,5-trichlorophenoxyacetic acid on to an area of forest in Kenya resulted in defoliation and death of a great many woody species, including large *Ficus* trees and two succulent species of *Euphorbia*. The role of a defoliant in increasing the light intensity and thereby allowing the rapid growth of the grasses during the rainy season was of particular interest, since a normally unburnable vegetation was destroyed by fire during the following dry season. Further work on arboricides in East Africa is now being carried out in conjunction with the Unit of Experimental Agronomy at Oxford.

After a short discussion, the meeting was closed by Sir Harold Tempany, who said that there is no doubt that, if world food production is to keep pace with the increasing population, extensive clearing of land will have to be undertaken prior to agricultural development and that the techniques and principles of bush and forest clearing discussed during the meeting are likely to have a very real value.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

AT the invitation of the Maidstone Scientific and Antiquarian Society and the Mayor and Corporation of Maidstone, the South-Eastern Union of Scientific Societies held its fifty-ninth annual congress at Maidstone during June 10–13 under the presidency of Dr. Glyn Daniel. The local committee for the Congress was under the chairmanship of Sir Garrard Tyrwhitt-Drake, with L. R. A. Grove as local secretary. At the young naturalists' evening Maxwell Knight lectured on "The Hand Rearing of a Cuckoo", illustrating his remarks with lantern slides.

The presidential address to the Archæological Section, on "The Present State of Monastic Archæology in Kent", was given by F. C. Elliston Erwood, who dealt with the development of monastic buildings, using Kentish examples to illustrate his points. In mentioning the difference between usual monastic buildings and those of orders of military origin, he emphasized the scope for the examination of the latter within the county. G. E. Newell gave the presidential address to the Zoological Section, his subject being "Animal Zones of the North Kent Coast". He said that the physical environment, the exposure of animals for long periods by tidal action twice daily and large thermal differences demand a toughness in the faunal population. The direction of the beach drift is from east to west, opposite to that often suggested as existing in the Thames Estuary.

Dr. Glyn Daniel's presidential address to the Union was on "The Art of the Megalith Builders". He commenced by saying that although Stonehenge had been examined and studied for a great number of years, it had only recently been noticed that some

of the stones had engravings, or decorations, upon them. He then spoke of the engravings on Megalithic stones in Anglesea (circles, lozenges and wavy designs), suggesting they may have been derived from Irish sources, and he compared them with similar patterns on examples in Brittany, Spain, Portugal and along the northern Mediterranean shore to its eastern limit, where engravings of an anthropomorphic character are well advanced. His address was illustrated by excellent lantern slides of subjects very difficult to photograph.

J. E. Lousley, as president of the Botanical Section, spoke on "The Amateur Botanist in 1954", saying that although botanical work now is so highly specialized that, besides expert knowledge, a modern laboratory is necessary, there still remains a great deal of work which can be successfully undertaken by the amateur. Mass observations on species and habitats are needed, and examples where amateurs can assist in collaboration with professional botanists are: a rose survey (charts would be provided and specialized knowledge is unnecessary); records of plant distribution within the vice-counties (plotting species upon maps using the 10-km. grid scale and marking with dots within the grid squares); noting the variation in numbers of a species in a known colony over a number of years; and the study of life-histories and of the method of conveyance of plants to new habitats, especially by the germination of seeds from bird droppings collected after careful observation. H. E. P. Spencer chose, for his presidential address to the Geological Section, the theme of "The Pleistocene Period and Work for the Amateur Geologist", and dealt with his recent work in East Anglia. He said that much remains to be investigated regarding the correlation of the fauna of the interglacial periods, and he suggested that amateurs could render considerable help by recording and collecting from temporary exposures. Norman Cook addressed the members on "Early English Antiquaries".

At the general assembly of the Union schemes for the development of its work were discussed and subjects for investigation outlined. Despite bad weather conditions, the full programme of excursions was carried out. The archæologists visited the Roman villa in course of excavation at Lullingstone, the Keep at Eynsford Castle now being excavated by the Ministry of Works, and Bodiam Castle. The botanists and zoologists went to Funton Creek, Queendown Warren, Bedgebury Pinetum and the Maidstone Zoo at Cobtree Manor. The geologists had an excursion to the Peninsula of Hoo to study the Tertiaries, the Chalk outcrop and the history and development of the North Kent marshes.

The sixtieth annual congress of the Union will be held next year in Folkestone during April.

BASIC SCIENTIFIC RESEARCH AND PUBLIC POLICY IN THE UNITED STATES

DESPITE the concern still being expressed in the United States regarding the adequacy of support for fundamental research, of which Dr. W. D. Coolidge's plea for more fundamental research effort (see *Science*, **119**, 110; 1954) is a recent example, there is not the same sharp note of anxiety on this score in the third annual report of the National Science Foundation*. Removal by Congress of the 15 million dollar ceiling upon annual appropriations to the Foundation has permitted the Foundation to assume greater responsibility for the support of basic research; and the Board of the National Science Foundation has been encouraged by the sympathetic understanding of its problems by many members of Congress, although misunderstanding of science and its methods is still widespread. Wider public understanding of science, scientists and the implications of scientific development is of vital concern, in the view of the Board, not only to the Foundation itself, but also to the Federal and State Governments, academic institutions and industrial concerns.

The limits of expenditure on fundamental research are now set, the Board believes, not by financial resources but by the numbers of men and women with the capacity, interest and willingness to pursue science. They constitute a restricted section of the population, and science is not the only profession calling for high intelligence and disciplined ability. Accordingly, solutions to many current problems reside in the long-term functions of the National Science Foundation, and in his foreword to its annual report, Mr. Chester I. Barnard, chairman of the Board, makes it clear that the Foundation is increasingly concerning itself with these long-term functions.

Fundamental research has three relatively immediate consequences: the production of scientific workers; the production of new knowledge, much of which may prove useful in ways unforeseeable to-day; and the application of the results of research to the solution of practical problems. These consequences could encourage a tendency to utilize the Foundation for secondary purposes and administrative convenience, or else government interposition in science to an extent which, by attempting to dominate, might destroy it. Mr. Barnard insists that the Board is alive to these dangers and determined to operate so as to minimize them; and this contention is fully supported by the most important section of the director's report, namely, that dealing with science and public policy.

The detailed work of the Foundation during the year is described by Dr. A. T. Waterman. Studies carried out by the Foundation of the Federal Research and Development Budget on which he here comments have already been noted in *Nature* (**172**, 575; 1953). Dr. Waterman states specifically that it will be desirable to review periodically the relative support furnished to fundamental and applied science; but he points out that centralization of support of fundamental research in the Foundation will not be in the best interests of science unless, together with other research agencies, the Foundation can provide sufficient support for fundamental research to bring it in balance with the support given to applied research and development. Moreover, if operating agencies are to carry on fundamental research programmes directly related to their operating functions, they must be assured of a continuous direct flow of fundamental knowledge relating to their practical problems, and their staff should be in effective touch with other scientific workers.

Dr. Waterman's report indicates certain steps already taken by the Foundation towards the

* The Third Annual Report of the National Science Foundation. Year ending June 30, 1953. Pp. vii+110. (Washington, D.C.: Gov. Printing Office, 1953.) 40 cents.

co-ordination of Federal research, and he refers to the appointment by the Foundation, in accordance with the recommendation of the President's Materials Policy Commission, of a committee to assist in formulating a broad programme of research and training directed towards strengthening the exploration and discovery of mineral resources; the development of measures to finance and execute such a programme; and the identification and study of background data and questions of policy which affect the conduct of research and training in this field. Of even wider interest, however, is the section of this report which deals with travel restrictions on foreign scientists, and this puts the question of contacts between scientific workers in its widest perspective.

Dr. Waterman then turns to the question of admission of foreign scientists to the United States. Since the restrictions were enlarged between 1948 and 1950, and afterwards embodied in the codified law which became effective in December 1952, it has been the practically unanimous opinion of scientific workers that relations between American scientists and their opposite numbers in countries friendly to the United States, particularly in the United Kingdom and other countries in Western Europe, have deteriorated. At least half of all foreign scientists who apply to enter the United States meet difficulties or serious delays. Refusals of permission to enter are much less frequent, and the chief damage to international relations arises from a few instances of refusals to outstanding persons, and from the tediousness and uncertainty of the procedure even for those who are admitted.

In testifying in October 1952, before the President's Commission on Immigration and Naturalization, concerning the impact of existing immigration laws on science, Dr. Waterman pointed out that creative scientific ability is not circumscribed by national boundaries. He referred to America's dependence on findings and accomplishments in pure science abroad in achieving her own advanced technology and standards of living. Excluding students, about three thousand foreign scientists are estimated as having visited the United States in 1951, and Dr. Waterman said that their importance to the scientific strength of the United States was out of all proportion to their number, as, generally speaking, they represented the best scientific minds of the free world outside the United States.

In closing his comment, Dr. Waterman made four specific recommendations which would, he believed, achieve a better balance between security by isolation and security by technological achievement. First, he suggested a distinction between procedures and criteria for temporary admission, particularly a visit of a few weeks or months, and those for permanent residence. For the former, he suggested that the criterion for exclusion might rationally be based on present sympathetic association with a foreign subversive organization, rather than, as now, affiliation in an extremely broad sense of the word at any time in the past with such an organization. Third, he suggested that provision should be made for selective audit from time to time of applications for temporary admission by a competent, reliable and disinterested group with appropriate experience both inside and outside government. This suggestion is prompted by the wealth of experience accumulated with security programmes in which a balance must be struck between isolation and technological achievement.

Lastly, if these suggestions prove impracticable, Dr. Waterman recommends the establishment of a separate section of the immigration law, creating a simplified and expeditious system for admitting students, trainees, teachers, guest research workers, professors and leaders in fields of specialized knowledge and skill who have applied for admission for a purpose directly related to the activities of a government agency, an accredited institution of higher learning or a scheduled meeting of an accredited international professional organization.

It is not known what reception these proposals met; but if in due course even the fourth only is adopted, some of the friction at present experienced should be removed and a real contribution made to the exchange of thought, of experience and of knowledge upon which the advance of science and technology alike depend. As Dr. H. W. Dodds, president of Princeton University, remarked in a recent comment in the *Universities Quarterly* on the Seventh Congress of the Universities of the Commonwealth last July, one welcome result of the presence of its American guests was to remove some misunderstandings outside the United States as to the extent to which current Congressional practices have endangered freedom of scholarship and of communication. None the less, it would be ungenerous not to welcome the firmness of Dr. Waterman's evidence in favour of scientific and technological mobility and communication or to fail to note that the leadership of the National Science Foundation is in the hands of those who understand so clearly the fundamental conditions of the advancement of science and technology and who are not afraid to add their testimony to that of other leaders in science, scholarship, teaching or industry, whether in the United States or elsewhere in the free world.

PLANT GENERA

THE Chronica Botanica Co. has once again placed botanists in its debt by bringing together the papers of a symposium (Cornell, 1952) of the American Society of Plant Taxonomists and the Botanical Society of America under the title of "Plant Genera, Their Nature and Definition" (*Chronica Botanica*, 14, 3, 89–160; 1953; 2 dollars; Chronica Botanica Co., Waltham, Mass.; Wm. Dawson and Sons, London, W.C.1). The book contains a foreword by Dr. Frans Verdoorn, an introductory essay by Dr. Th. Just on "Generic Synopses and Modern Taxonomy" and the following symposium contributions: "Plant Genera, their Nature and Definition: the Need for an Expanded Outlook", by Dr. G. H. M. Lawrence; "The Anatomical Approach to the Study of Genera", by Dr. I. W. Bailey; "Floral Anatomy as an Aid in Generic Limitation", by Dr. A. J. Eames; "Cytogenetical Approaches to the Study of Genera", by Dr. R. C. Collins; "Cytology and Embryology in the Delimitation of Genera", by Dr. M. S. Cave; and "Plant Geography in the Delimitation of Genera: the Role of Plant Geography in Taxonomy", by Dr. H. L. Mason. Interleaved with these essays are facsimiles from early generic Floras.

As the above titles indicate, the nature of the botanical genus in its many aspects and relationships is very fully reviewed and discussed; and while the delimitation of genera in all classes of plants by hard-and-fast rules has not yet been found possible, there is general agreement that the genus is probably the

most natural, comprehensive, useful, important and effective taxonomic unit applicable to all groups. It is probably also the unit—the genus being most simply defined as a group of related species—of greatest use to the non-taxonomic botanist.

In his discussion of the difficulties of generic delimitation, Dr. Lawrence considers that taxonomists must function as synthesizers, and bring to bear on each problem all relevant data from related fields of botanical study. He also suggests a number of practical steps which may be taken to achieve this desirable end. Dr. Bailey considers that it is essential to determine what contributions anatomy can actually make to taxonomy, since some characters that appear to be relatively stable in some groups may be highly plastic in others; that is, internal characters are inherently no more reliable than external ones. One of his conclusions is that, because the anatomical approach is so time-consuming, it should in the main be reserved for those specially difficult problems where the significance of the results is likely to justify the effort expended. The anatomical approach to taxonomy has been especially rewarding in certain groups, in particular in certain ancient and primitive woody dicotyledons. Dr. Eames points out that, in taxonomic and phylogenetic studies, the internal structures of the flower are just as valuable as, and, in some instances, for example, where parts are vestigial, may be even more valuable than, the external form. But the evaluation of internal floral structures, as evidence of natural relationships, requires a wide knowledge of this field of observation and an awareness of the prevalence of evolutionary parallelisms and convergences. At the generic level, groups of floral anatomical characters, and even some rather specific ones, may be surprisingly well defined. Dr. Eames gives many interesting examples of the application of floral anatomy to problems of taxonomy; in the Ranunculaceae, for example, which has long been regarded as a "very natural family", the anatomical evidence yields a quite contrary view, and indicates that some of the included genera should be raised to family status. This illustrates the critical importance of the combined taxonomic and anatomical approach.

In a critical discussion of the cytogenetical contribution to the delimitation of genera, Dr. R. C. Rollins makes the point that, in determining the nature and limits of a particular genus, it is not a question that the investigation must be done at the generic level or not at all: rather, the interest should centre on the relatedness of the species involved; and it is here especially that cytogenetics can make an important and, in some instances, essential contribution. Examples are cited where the genetical evidence has pointed the way to the correct generic placing of previously intractable species; but because of the time involved, genetical studies can only be directed towards especially favourable groups.

The value of a knowledge of chromosome numbers in taxonomy is critically considered and the use and limitations of the data assessed. Chromosome number affords valuable evidence for taxonomic purposes in some instances but not in others. Where the chromosome number is constant within a genus, a useful test is available for the inclusion or exclusion of a species where doubt as to its affinity exists; on the other hand, if both aneuploidy and polyploidy occur within a genus, the cytological evidence may not be of much assistance in delimiting the genus, although it may be useful as an indication of relationships between the species. It is held that chromosome morphology, critically ascertained, may perhaps offer greater possibilities in generic definitions than chromosome numbers; but where the chromosomes are of very small size, or present in large numbers, this approach tends to be beset with difficulties. The general conclusions reached are that chromosome study provides, for taxonomic purposes, essentially the same kind of evidence as that derived from other parts of the plant, and that cytogenetics may aid substantially in the construction of the kind of generic classification that most adequately reflects the evolutionary relationships of the component species and of the families to which they belong. The respective contributions of embryological and plant geographical studies to an understanding of genera are also adequately discussed. The general effect of this collection of papers is to bring before the reader a fund of valuable and interesting information on many aspects of botany as they relate to a central and traditional theme.

STUDIES IN SOCIAL ANTHROPOLOGY

SIR JAMES FRAZER, a classical scholar and a type of prehistorian more than he was a historian, was interested in what he termed "the general laws which have regulated human history in the past, and which if nature is uniform may be expected to regulate it in the future". The lecture by Prof. Max Gluckman on "Rituals of Rebellion in South-East Africa"* is the Frazer Lecture for 1952, and that by Prof. M. Fortes†, which is his inaugural lecture as William Wyse professor of social anthropology in the University of Cambridge, is in agreement with Frazer, Haddon, Malinowski and Radcliffe-Brown that there are regularities independent of period and place in social organization and culture, defined as morals, law, custom and socially acquired capabilities and habits. Therefore, it is appropriate to consider here Frazer on the topic of uniformities about man's natural status.

Frazer was distinctly uncritical in his acceptance of what missionaries wrote about primitive culture and personality. For example, of the Kai Papuans of the 1899–1902 and earlier period, Charles Keysser remarked that they were fearful of the military power of an enemy, and parsimonious about making payments to allies whom they needed to mount successful offensives, preferably with superior force, against some neighbouring small group of Kai they termed sorcerers. On account of these traits of character, the leaders of the small territorial groups into which the natives were divided before their conquest sometimes delayed launching attacks against sorcerers for some interval of time after their fellows' deaths which they regarded as provocations. They attributed droughts, inroads of garden pests, bad luck in hunting and epidemics of colds in the head, which sometimes supervened in time of delay and of unreadiness for mounting attacks against sorcerers, to the wrath of the spirits of their kindred, which they worshipped in a manes cult, but whose deaths—to discuss dead men as if they were spirits—had not

* Rituals of Rebellion in South-East Africa. (The Frazer Lecture, 1952.) By Prof. Max Gluckman. Pp. ii+36. (Manchester University Press, 1954.) 3s. 6d.

† Social Anthropology at Cambridge since 1900: an Inaugural Lecture. By Prof. M. Fortes. Pp. 47. (Cambridge University Press, 1953.) 2s. 6d.

provoked prompt retaliatory (that is, offensive) attacks against sorcerers.

The Kai thought that the greatest love and the deepest sympathy which they could display to their dead was to retaliate for their dead against sorcerers, and so help their spirits to attain rest and peace in the other world, which in their belief was an underworld to which the spirits went about the time the flesh decayed on the skeleton. If the Kai had not feared the ghosts of their fellows more than they feared the military power of an enemy, and more than they valued their savings of shell ornaments, boars' tusks and pork, which they expended to procure allies, they would not have launched their offensives against sorcerers, but would have remained peaceful. The Kai of the 1902–11 period under German administration up to the date of Keysser's publication in "Deutsch Neu Guinea" (edited by R. Neuhauss) were peace-loving by nature, and in this respect considered to be comparable to Germans.

Keysser's views on the topic of Papuan tribal culture and personality require critical analysis. Sir James Frazer, however, searching for general laws of prehistories, uniformities of human nature and expected regularities of histories, accepted Keysser without question, attributed homicides in connexion with sorcery once held justifiable by Australian aboriginals, some Melanesians and some Papuans to ghost fear, and compared primitive warring about pretexts proper to a general belief in magic with European wars over religious differences. In his work "The Belief in Immortality" (Vol. 1) he summed up this view of uniformity in human nature, and of general laws which have prevailed in human history, with the remark: "The state of war, which normally exists between many, if not most, neighbouring tribes, springs in large measure directly from their belief in immortality; since one of the commonest motives for hostility is a desire to appease the angry ghosts of friends, who are supposed to have perished by the baleful arts of sorcerers in another tribe, and who, if vengeance is not inflicted on their real or imaginary murderers, will wreak their fury on their undutiful fellow tribesmen. Thus the belief in immortality has not merely coloured the outlook of the individual upon the world; it has also deeply affected the social and political relations of humanity in all ages; for the religious wars and persecutions, which distracted and devastated Europe for centuries, were only the civilized equivalents of the battles and murders which the fear of ghosts has instigated amongst almost all races of savages of whom we possess a record".

The remark is an instance of error in an attempted explanation of miscellaneous facts in a formula about motives and character. Another instance of the kind is the thesis of "The Golden Bough", which discusses in odd places the homicides of divine kings by their successors, with no good reduction of miscellaneous facts to a formula including the affair of Cromwell and Charles I, or the homicide of a Hapsburg in Serbia in 1914. Ruth Benedict and Margaret Mead have also written anthropological works in the culture and personality field; but, as Bernard Notcutt notes in his recent work entitled "The Psychology of Personality", what the subject needs at the moment is some kind of discipline. Papuan culture, although it varied somewhat in different areas of New Guinea, probably did not vary in an entirely disorderly manner; and partly with an intention of testing Margaret Mead's theories about Papuan character, we studied bow-and-arrow fighting over sorcery among the Kamano Papuans in 1935. The Kamano said upon question in 1951–52 about motive that they had not thought that the spirits of their dead needed their former actions against sorcerers of them; they had not maintained a doctrine that ghosts required the deaths of sorcerers; and they had not feared ghostly commination for delay in launching offensives, although they had not delayed. The provoking natural deaths which had preceded the fighting incidents we had seen in 1935 had taken place one, five days before an incident broke out, and one nine days before another. We investigated antecedents and sequences in detail; but there is no space to discuss them here.

Nature, when known, is a critic of such gross imputations of responsibility for the purpose of punishment or of dispute of land tenure as may be implied by the belief in sorcery as the cause of death, and one may be interested in the truth or error of statements claiming to state uniformities about man's natural status without expectation that men will return to prehistoric conditions. Prof. Fortes's inaugural lecture takes issue with a view expounded by Evans-Pritchard in his "Social Anthropology" that 'social systems' are not 'natural systems' and that therefore social anthropology and sociology need not have as their aim statements of uniformities about man's natural status. Prof. Gluckman discusses first-fruit rituals of the agricultural year among the Zulu and the Swazi. The thesis is that ritual expresses the tensions of the social organization. A similar thesis is maintained by Evans-Pritchard in his Frazer Lecture for 1948, "The Divine Kingship of the Shilluk" of the Nilotic Sudan, with a note that there was no knowledge that actual regicide had occurred often in their unwritten past.

R. F. FORTUNE

THE HANFSTAENGL COLOUR COLLOTYPE REPRODUCTIONS

THE colour reproductions of old and modern masters, printed and published by the firm of Hanfstaengl of Munich, which since the beginning of the War were unobtainable in many countries, are happily once more available. The firm of Hanfstaengl is well known for the high quality and fidelity of its reproductions; moreover, it has covered a very wide range of original paintings and schools—from the classics to the impressionists and expressionists.

The Pallas Gallery, Ltd., 28B, Albemarle Street, London, W.1, are sole agents in Great Britain and the British Commonwealth for Messrs. Hanfstaengl, and has recently issued a well-illustrated catalogue of the 150-odd prints now available. The prices are 42*s*., 52*s*. 6*d*., 63*s*., and 73*s*. 6*d*.; and some four-colour prints (20 in. by 16 in.) may be obtained at 21*s*. each.

Among the various artists represented are (with examples given in brackets): Italian School (Titian, Botticelli); German School (Dürer, Holbein); Flemish and Dutch Schools (van Dyck, Rubens); French Impressionists (Renoir, Monet); Post-Impressionists (Cézanne, Gauguin, van Gogh); School of Paris (Matisse, Picasso); Kokoschka; German Expressionists (Marc); German Romantics (von Hess); and a collection of decorative pictures including landscapes (Heffner, Mercker), animal paintings (Olszewski,

Roloff) and flower pieces and genre pictures (Berndt).

The sample reproduction submitted for review is "Horses in a Storm" by A. Roloff (24 in. by 29¾ in., 52*s*. 6*d*.). This print admirably conveys the feeling and tonal qualities of the original, for the impasto, though evident, is not intrusive. From the purely technical point of view, closer register in the printing would have added to the excellence of this reproduction; but this does not detract from the fact that it is a splendid piece of printing. Moreover, the reproduction itself conveys the gripping vitality of the original; yet withal it is unusual among horse paintings in that the artist strikes the reviewer as having, with consummate cunning, transferred action and virility from the animals to the elements around them. So excellent is this reproduction of a superb painting that anyone would surely be proud to possess it.

Men of science, whether academically interested in art or practically concerned with *décor*, would do well to examine this catalogue (a piece of good printer's art in itself). Geographers and natural historians might show more specific interest and appreciation; but all will be grateful to the Pallas Gallery, Ltd., for making these prints again available, and at such comparatively modest prices.

L. J. F. Brimble

AMERICAN PHILOSOPHICAL SOCIETY

YEAR BOOK FOR 1953

THE "Year Book 1953" of the American Philosophical Society* covers the year ended December 31, 1953, and includes the customary brief history of the Society, and a copy of its charter and laws, together with lists of officers and committees and members, biographical memoirs and the reports of standing committees. The report of the Committee on the Library refers to satisfactory progress in implementing the Darwin programme and says that the search for secondary material pertaining to the evolution theory is meeting with much success; nearly five hundred volumes have been added, and more letters to and from Darwin and his associates have been acquired. The collection promises to become one of the foremost on the subject in the world.

More than a third of the volume is occupied by the report of the Committee on Research, which details 151 grants, totalling 135,661 dollars, from the Penrose Fund, eight, totalling 15,750 dollars, from the Johnson Fund, and eight, totalling 15,255 dollars, from the Daland Fund for Research in Clinical Medicine. Five grants, totalling 15,700 dollars, were also made during the year from the Michaux Fund. This part of the report consists mainly of brief reports from recipients of grants, arranged alphabetically by sciences. Among the more detailed of these summaries may be mentioned those of the following: O. Struve, on measurements of the spectrum of Capella, which point to 0·9 for the mass ratio of the cool component to the hot component; H. L. van Dyke, on the formation of alkylbenzenes through the Friedel–Crafts, Fittig and Grignard reactions; H. S. Colton, on Lower Pliocene mammalian fauna from near Walnut Grove, Yavapai County, Arizona; R. Chambers, on studies of the permeability of the egg of *Fundulus* (sea minnow) to water and electrolytes, which suggest that the constant plateau level of the pressure observed when the eggs, activated by puncture, were freshly shed into sea water, is due largely, if not entirely, to the ability of the perivitelline colloid to hold water, and possibly electrolytes, irrespective of the tonicity of the surrounding media; S. S. Roback, on the tendipedid larvæ of the Philadelphia area; R. I. Sailer, on the significance of hybridization among stink bugs of the genus *Euschistus*; and T. A. Stephenson on plant and animal ecology of the seashore between tide-marks in the Bermuda islands in which a flourishing colony of the unusual barnacle *Catophragmus imbricatus* was discovered, and evidence obtained that the progressive smoothing-off of the æolian limestone around Bermuda between the high-water and low-water level is due to a considerable extent to the browsing activities of beaked fishes and of various invertebrates. F. W. Crane, studying the diagnostic characters of fern spores, particularly of *Dryopteris*, reports that the species of *Dryopteris* observed can be separated on the basis of spore characters, that the hybrids are easily recognized as such by their peculiar spore production and that hybrid spores are not in themselves completely diagnostic; the morphology of the specimen must be considered. J. Merkle reports on an ecological analysis of the meadows on the Kaibab Plateau, Arizona; F. D. Reed on progress with a monograph on the Calamites; D. J. Rogers on variations in *Manihot utilissima* and related species in Jamaica and Costa Rica; and W. A. Weber on variation in *Balsamorhiza* (Compositae).

R. A. Waterman describes an ethnological and ethnomusicological field investigation of the aboriginals of Yirkala, North-Eastern Arnhem Land, Australia; N. C. Li reports on his investigations on the stability of zinc complexes with glutathione and oxidized glutathione and of copper II complexes with oxidized glutathione; D. W. Wilson on investigations of the biochemistry of nucleic acids with the Beckman ultra-violet spectrophotometer and the International refrigerated centrifuge; and L. W. Bluemle on the application of extra-corporeal hæmodialysis to remove œdema fluid, re-evaluate the toxic factors in uræmia and in studying the effect of dialysis upon the production of urea, in which the value and versatility of the artificial kidney in treating and investigating problems of fluid and electrolyte metabolism have been demonstrated.

Among reports on research work grouped under the humanities which are of scientific interest may be noted those of E. G. Allen on John Abbot, the ornithologist of Georgia, which should facilitate the writing of his biography as well as an account of his pioneer work in natural history in America; G. E. Fay on the archæological cultures of the southern half of Sonora, Mexico; A. J. B. Wace on excavations at Mycenæ, Greece; S. S. Weinberg on the comparative archæology of the Ægean and the Near East in the Neolithic period; W. D. Wallis on the ethnography of the Maliseet (Malicete) and of the Micmac Indians of New Brunswick, Canada; and G. M. A. Hanfmann on the development of geometric and orientalizing art in Ionia with special reference to vase-painting and minor arts.

* American Philosophical Society. Year Book 1953, January 1, 1953–December 31, 1953. Pp. 517. (Philadelphia: American Philosophical Society, 1954.)

MEASUREMENT OF EYE MOVEMENTS ACCOMPANYING VOLUNTARY HEAD MOVEMENTS

By F. HODGSON and Dr. MARY P. LORD

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AMONG the many methods of eye-movement measurement which have been described, that using the corneal–retinal potential difference is notable for causing minimum interference with the subject. The method has been fully described elsewhere[1]; but a brief résumé will be given here.

A steady potential difference exists between the back and front of the eye, the latter being more positive; the magnitude of the potential difference is of the order of 1–2 mV. As a consequence of this, when the eye moves to left or right, a change occurs in the potential difference between points on the skin on either side of the eye; a similar change occurs between points above and below the eye when the eye moves up or down. These potential changes can be detected by pairs of electrodes attached to appropriate points on the skin. When amplified and recorded, the changes may be used to deduce the horizontal and vertical deflexions of the eye, since they may be shown to be directly proportional to the angular displacement of the eye. For the measurement of horizontal eye movements, the electrodes may be placed, either one on each temple, giving the movements of both eyes, or one on the temple and the other on the nasal bone on the same side, giving the movements of one eye only.

The corneal–retinal potential method has the further advantage that, if flexible leads are used for connecting the electrodes to the amplifier, the head is quite free to move, and therefore eye movements occurring during head movements may be investigated.

In the present experiments, movements of the eyes and head about vertical axes have been recorded simultaneously. The electrodes used were concave copper disks 1 cm. in diameter, placed one on each temple and held in position by adhesive tape. A third electrode of 2 cm. diameter was fastened behind one ear and connected to earth. Light screened leads connected the electrodes to a high-gain symmetrical d.c. amplifier, the output of which operated a push–pull cathode-follower output-stage[2], driving one pen of a multichannel recorder unit. The sensitivity of the method was limited by the noise-level of the 50-c./s. pick-up from the subject, which was usually equivalent to ¼–1° of eye movement. To keep the 50-c./s. hum at this low level, it was necessary to lower the skin resistance of the subject to not more than 2,500 ohms. This was effected by using saline jelly, contained in the hollow of the electrode for the actual skin contact, and by thoroughly cleaning the skin with electrode jelly and cotton wool. To eliminate noise caused by the leads pulling the electrodes when the head moved, each lead was attached to the skin with adhesive tape, about 1½ in. from its electrode.

Preliminary photographic work had shown that the head can, when free, rotate about a single near vertical axis; the inclination of this axis to the vertical depended on the sitting posture of the subject. Head movements about this axis were recorded simultaneously with the eye movements by another pen of the multichannel recorder. Each subject wore a plaster cap (Fig. 1) in the top of which was embedded a 5/16-in. spindle, placed so as to coincide with the axis of rotation of the head. To ensure that the spindle rotations followed those of the head completely, a dental wax impression was made for each subject, and rigidly connected to the plaster cap by a brass rod and strips, as shown. The spindle was connected by a flexible bellows-type coupling to the spindle of a linear potentiometer. The potentiometer was held in a cradle above the head of the subject, who was seated in a specially constructed chair; provision was made for the potentiometer axis of rotation to be tilted slightly from the vertical, if necessary. A potential difference of 360 V. was applied to the terminals of the potentiometer, and the output from the slider was applied to the grid of an output valve, which operated a second pen of the recorder.

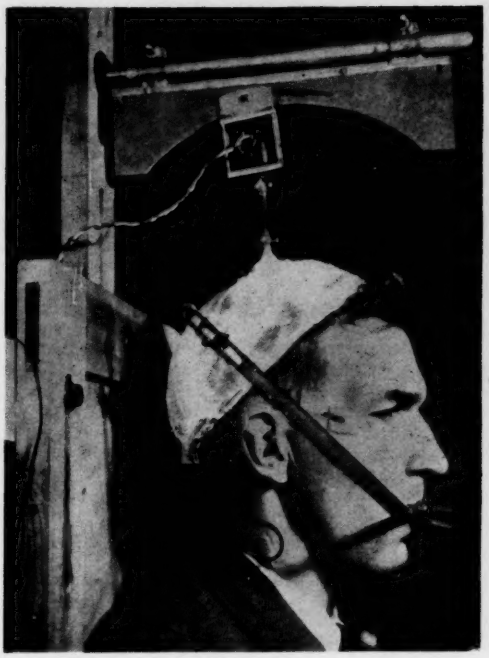

Fig. 1. Head-movement apparatus and electrode positions

A third pen of the recorder produced time markings at the rate of 10 per second, being connected to a multivibrator, synchronized by the 50 c./s. mains.

The apparatus has been used for investigating eye movements associated with two types of side-to-side head movements: those performed in the subject's own time without significant pause at the extreme positions; and those performed at the operator's request with pauses of a second or so at the extreme positions. In both cases, three speeds of movement were attempted—fast, medium and slow. Movements of the eyes with no attention paid to the eyes have been recorded for both types of head movement. For the first type only, eye-movement records have been obtained when the subject tries to maintain his eyes in the central position relative to the head. In all cases, records have been obtained for eyes both open and closed.

A detailed account of the results obtained will be published elsewhere. It would appear that the eye-movement pattern is largely determined by impulses arising from the head-movement stimulus rather than by the subject's will, since almost all eye-movement records show a similar saccadic pattern; the magnitude and frequency of the saccades depended on the speed of head movement. However, the saccade-rate was greater when the subject attempted to keep his eyes in the central position in the head than when no attention was paid to the eyes; moreover, further investigation showed that the subject can maintain fixation on a stationary object while moving the head. The records also show that the head movements from a position of prolonged rest were retarded relative to the eye movements; this may be due to the greater inertia of the head compared with that of the eye—from an instantaneous position of rest, the head moved before the eye. The effect of closing the eyes seems to be merely one of damping.

We wish to thank the subjects, Messrs. I. M. Gibson, B. Moffitt and E. J. Spain, with all of whom we have had stimulating discussions, and Mr. G. Mallet for assistance with the construction of the apparatus. The continued financial support of the Medical Research Council is gratefully acknowledged.

[May 5.

[1] Carmichael, L., and Dearborn, W. F., "Reading and Visual Fatigue" (Harrap, 1948).

[2] Asher, H., *Electronics*, **23**, 170 (1951).

ELECTRON DIFFRACTION DIAGRAMS OF CELLULOSE MICROFIBRILS IN *VALONIA*

By Prof. R. D. PRESTON, F.R.S., and G. W. RIPLEY

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ELECTRONMICROGRAPHS of native cellulose (cellulose I) invariably reveal the presence of long narrow threads, termed microfibrils, whatever the source of the cellulose may be. In view of the known structure of cellulose, derived in the main from X-ray diffraction studies of comparatively very much larger specimens, it is equally invariably implied that these microfibrils are composed of molecular chains of cellulose lying more or less parallel to each other. It has indeed been claimed, using arguments based on the breakdown of cellulose in sulphuric acid, that the microfibrils are built from sub-units resembling 'micelles' and should therefore be referred to as 'micelle strings'[1]. Direct evidence has so far, however, been lacking.

In the course of a reinvestigation of the structure of the walls of *Valonia*, we have found it possible so to modify our Philips electron microscope as easily to record electron diffraction patterns. These to a large extent provide the direct evidence as to the structure of microfibrils. Since, in addition, they have a distinct bearing upon the statements which have recently been made concerning the wall structure of *Valonia*[2], they are presented at this time as being relevant both to the general problem of cellulose structure and to the special one of *Valonia* cellulose.

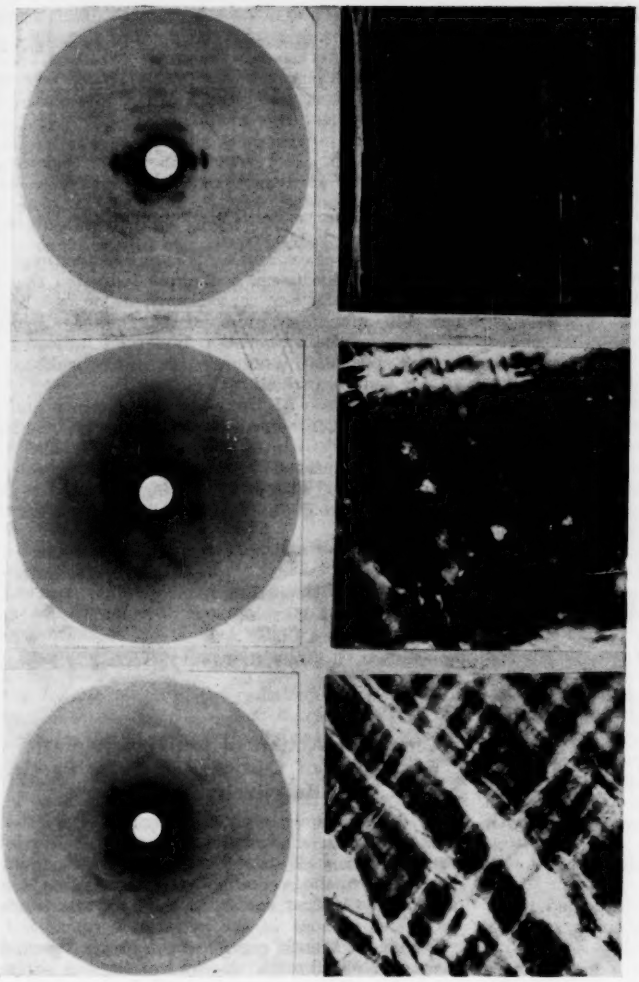
Material has been examined of *V. macrophysa* collected at Naples and of *V. ventricosa*, the specimens being prepared, as elsewhere described[3], as free from distortion as possible. The electrical circuits of the microscope have been so modified as to enable a considerable reduction in beam intensity and a reduction in the accelerating voltage across the electron gun to 25 kV. Under these conditions, electron diffraction diagrams which otherwise flash up and disappear in less than a second remain visible and essentially unchanged for many minutes. Three representative diagrams are presented in Figs. 1*a*–3*a* and the corresponding electronmicrographs in Figs. 1*b*–3*b*. The specimens were mounted without a supporting film and were, of course, unshadowed. Contrast is therefore lacking in the electronmicrographs, but the general run of the microfibril directions can nevertheless be seen.

In Fig. 1, the prominent equatorial arcs, beginning at the outside of the diagram, can be unequivocally referred to planes of spacing 3·9 A., 5·4 A. and a very weak arc at 6·1 A., which will be discussed later. Comparison with Fig. 1, *b* shows that the microfibril direction lies at right angles to this equatorial row of arcs, as would be expected if the molecular chains of cellulose lay along the length of the microfibrils. Equally, in Figs. 2 and 3, the two sets of microfibrils each lie at right angles to the corresponding row of arcs. This constitutes, therefore, direct evidence concerning the orientation of the cellulose chains within the microfibrils. The radial broadening of the arcs is, however, just as impossible of unique explanation as it is in X-ray diagrams from bulkier specimens.

Turning now to the special problem of the organization of the cellulose in *Valonia*, one or two relevant and important points may be made. The arc corresponding to planes of 6·1 A. spacing is recorded only when the specimen has torn and one edge has rolled up. In specimens which appear to be completely flat (for example, Fig. 2) this arc is missing. In this thoroughly desiccated material, therefore, the planes of spacing 6·1 A. tend to lie parallel to wall surface, just as they were shown to do in air-dried material by the X-ray method[4]. It should further be recalled that a similar uniplanar orientation has been demonstrated in wet, living specimens of *Rhizoclonium*[5], a filamentous alga the wall structure of which resembles that of *Valonia* very closely. This orientation is therefore maintained over the whole range of water content. In quoting the opinion of Preston and Astbury, stated some sixteen years ago[4], that this orientation then observed in air-dried material might have been induced by dehydration, Steward and Muhlethaler[2b] have evidently failed to appreciate the more recent observations on fresh specimens[5].

The microfibrils do not therefore roll over markedly even under the intense desiccation in the electron microscope. It is consequently impossible to conceive that desiccation could effect a mass reorientation of the microfibrils such as Steward and Muhlethaler[6] seem to consider in comparing their three-layer repeat structure with the original two-layer repeat proposed by Preston and Astbury[4]. Whatever may be the cause of the discrepancy between the findings of Preston and Astbury[4] and Steward and Muhlethaler[6], it is quite incredible, on this as well as other grounds, that a change in orientation induced by desiccation can have any part to play.

The diagrams presented here are significant in still another way. The original findings of Preston and



Figs. 1–3. (*a*) Electron diffraction diagrams; (*b*) electronmicrographs of identically the same specimen, using lamellæ stripped from *Valonia macrophysa*. (*a*) and (*b*) are arranged in mutually correct orientation

Fig. 1. A single lamella. Note the single set of prominent equatorial arcs. Fig. 1, *b*, magnification 5,600. Note that the edge of the specimen to the left has rolled up. This has caused a weak 6·1-A. arc to develop in Fig. 1, *a*

Fig. 2. Two lamellæ, inter-microfibrillar angle about 60°. Fig. 2, *b*, magnification 6,000. Note the absence of an arc at 6·1 A. in Fig. 2, *a*

Fig. 3. Two lamellæ, inter-microfibrillar angle about 80°

Astbury[4], based on some 15,000 X-ray diagrams from many adult vesicles, were that the wall consists of two sets of lamellæ, the cellulose chains crossing at an angle which was variable from place to place in one vesicle, and from vesicle to vesicle, between about 60° and about 90°. Steward and Muhlethaler[6], from what must be far fewer observations and certainly based on a very much smaller bulk of material, claim that the wall is three-layered with an angle of 60° between the three sets of cellulose microfibrils. We have taken up to the present at least two dozen electron diffraction diagrams and these lend full support to the findings of Preston and Astbury[4]. None of them reveals the presence of more than two sets of arcs even when three sets of microfibrils are visible in the electronmicrograph of identically the same specimen. We do not propose at the moment to lay any stress on the absence of diffraction from one set of microfibrils since it is difficult to be sure that all three sets are present in equal amounts; but rather to emphasize that the commonest type of observation is that recorded in Fig. 3. If, in such cases, there could be lamellæ with a third orientation stripped away during specimen preparation, then the mutual angle between the microfibrils could not be anywhere near 60°. On the whole, the evidence at present available in mature vesicles leads firmly to a basic structure of two sets of microfibrils at an angle less than 90° to each other, with an occasional third set interspersed. Only in the special circumstance that the angle between the two basic sets is 60° can there then be, even sporadically, three sets at 60°.

It is not proposed to comment further on the special case of *Valonia* until further work in progress is completed. Two general facts may, however, be quoted which have not hitherto been mentioned in the discussions on *Valonia*. First, it is now quite clear that some, perhaps many, algal walls reveal the presence of microfibrils in the electron microscope but yield only very diffuse X-ray diagrams. Not all microfibrils visible, therefore, are crystalline or, indeed, cellulosic[7]. Secondly, some algæ other than *Valonia*, notably the Cladophorales (except the *Spongomorpha* group), show the same type of wall structure as *Valonia*[8]; and here only two sets of microfibrils have been reported, and both the interchain angles (derived from X-ray diagrams) and the intermicrofibrillar angle (observed in the electron microscope) are commonly about 90°. The condition in *Valonia* should therefore not be dealt with solely as a special case but should be interpreted in terms of this very wide background we now have of algal wall structure generally. [May 13.

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LETTERS TO THE EDITORS

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Synthesis of Branched Polymers

Little is known about the behaviour of branched-chain polymer molecules either in solution or in the solid state. One of the difficulties hindering the acquisition of this knowledge is the lack of synthetic methods for building molecules to a predetermined pattern. This communication is concerned with one approach to a solution of this problem in the case of vinyl polymers. Polystyrene may be taken to illustrate the application of the method.

Polystyrene in solution in carbon tetrachloride is brominated photochemically at room temperature until the bromine content rises to about 5–10 per cent. The brominated polymer is dissolved in styrene monomer and the solution irradiated with ultra-violet light of such a wave-length that the bromine atoms are removed, leaving polymer radicals and free bromine atoms both of which initiate polymerization, branches growing from the polymer radicals. Unless the bromine content of the initiating polymer is very low the product is precipitated as a gel, showing that cross-linking has occurred by the radical branches combining[1]. However, cross-linking may be prevented by the addition of carbon tetrachloride, which then acts as a transfer agent and gives rise to shorter branches. By a judicious choice of conditions it is possible to obtain a mixture of branched-chain polystyrene and linear polystyrene so different in molecular weight that the two components may be separated by fractional precipitation. From the fractionation results, it is possible to estimate the weight fraction of high polymer molecules present as branches. The use of styrene monomer labelled with carbon-14 for the branch-growth polymerization makes possible an alternative determination of this quantity.

The determination of the number of branches per molecule is more difficult. From the observed rate of polymerization it is possible, with a knowledge of the velocity constants of propagation and termination and of the transfer velocity constant of the styrene radical for carbon tetrachloride, to calculate the average length of the branches.

Unfortunately, transfer constants are not known with a very high degree of precision. Determination of the average length of the branches and the weight fraction of the branches enables a simple calculation of the frequency of the branches. A second method is available for determining the frequency of the branches. The branched polystyrene will have a smaller bromine content than the starting material partly because of the dilution effect of the added branches and partly because each branch replaces a bromine atom. The bromine contents of a brominated polymer before and after branching were determined by the neutron activation technique and provided data for the calculation of the number of monomer units in the backbone of the polymer per branch. The results of a number of branching experiments are summarized in the accompanying table.

Expt. No.	% branching	Chain-length of branches (P_n)	No. of monomer units of backbone/branch	Mw of backbone	Branches per molecule
*A*1	37	130	220	300,000	14
*E*3	39	310	480	900,000	19
*E*4	25	95	290	900,000	31
*F*1	34	230	450	200,000	4·5
*F*2	37	230	390	200,000	5

The branching figures given in the table have been calculated from the fractionation data. The molecular weights of the backbones of the polymers have been estimated from viscosity measurements on the brominated linear polystyrene.

In the case of experiment *F*1, radioactive monomer was used. This tracer technique indicated that the product was 35 per cent branched, or one branch per 430 monomer units of backbone. Bromine analyses on the branched polymer *F*1 indicated one branch per 350 monomer units of backbone or 40 per cent branched.

Experiments with radioactive monomer and the determination of bromine by neutron irradiation were carried out in collaboration with Dr. J. C. Bevington, whose advice and assistance are gratefully acknowledged. The work is being extended to other vinyl polymers.

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Chemical Action of Ionizing Radiations: Excitation of Optical Levels by Particles of Relatively Low Energy

It is well known that the energy lost by the fast particles of ionizing radiations is ultimately used for the excitation of discrete states, for ionization and for giving to the secondary electrons kinetic energies less than the first excitation-level of the atoms or molecules present in the system[1].

When the kinetic energy of the charged particles is large compared with the ionization and excitation potentials of the atoms or molecules present, excitation (and ionization) will be distributed among all the atoms and molecules in the system according to their relative proportions. However, as the particles are slowed down, they are no longer able to excite those species the excitation potentials of which are greater than the kinetic energy of the exciting particles. Therefore, from a certain point, excitation (and ionization) will be confined to atoms and molecules with a sufficiently low excitation (and ionization) potential; these processes will go on as long as the kinetic energy of the charged particles is greater than the lowest electronic excitation potential.

A case which is of particular interest is represented by dilute aqueous solutions of many organic and inorganic compounds. It is well known[2] that water itself does not absorb light of wave-lengths greater than about 1800 A., as its first continuous absorption band stretches from 1430 to 1860 A. with a maximum at 1665 A. ($\sim 7{\cdot}5$ eV.). Therefore, in dilute aqueous solutions, at electron energies greater than about 7·5 eV., chemical effects will be due mainly to the action on the water ('indirect effect'), as most of the radiation energy will be absorbed by the solvent

(water). In this region, there will only be a relatively small 'direct effect' on the solute, proportional to its concentration. However, the situation will be different when the exciting particles have energies less than about 7·5 eV., as in this region excitation of optical levels of substances with absorption bands in the nearer ultra-violet and in the visible region may become important.

Although it is difficult to give a detailed theoretical treatment of this effect, the action of charged particles should, according to Fermi's theory[4], lead to the excitation of atoms and molecules, and could produce an effect similar to the photo-excitation by a light quantum of corresponding energy. From Fermi's theory[4] the cross-section, q, for such an excitation process is given, to a first approximation, by:

$$q \propto [\int \alpha(\nu) d\nu]/v^2,$$

where $\alpha(\nu)$ represents the optical absorption coefficient for the frequency ν and v is the velocity of the particle; thus, this excitation cross-section is proportional to the optical transition probability and inversely proportional to the square of the velocity of the exciting particle.

It is obvious that the yield of this excitation effect is proportional to the concentration of the solute component under consideration. Therefore, this effect will, in general, lead to a dependence on the concentration of the solute, which is different from that arising through the interaction of the solute with the radicals formed by the 'indirect effect', that is, by the action of the radiation on the solvent.

Some estimate of the order of magnitude of the increase in the chemical yield due to this 'direct' effect can be made as follows: if one assumes that the energy (W) necessary to create an ion pair in liquid water is of the same order as in the gaseous state ($\sim$ 33 eV.), about three electrons will be produced per 100 eV. Under optimum conditions, that is, when each of these electrons would be capable of exciting one molecule, one may get an additional yield of three excited molecules per 100 eV., due to the low-energy electrons.

For example, with methylene blue (Mb) as solute, the three excited methylene blue molecules, (Mb*), could lead eventually, by reaction with a suitable acceptor (Acc), to three molecules of the corresponding semiquinone (MbH) similarly to the photochemical reaction[5], namely:

$$Mb^* + Acc \rightarrow Mb^- + Acc^+; \quad Mb^- + H^+ \rightleftarrows MbH.$$

On the other hand, electronic excitation of a molecule such as hydrogen peroxide should lead to a dissociation resulting in an additional yield of ($3 \times 2 =$) 6 hydroxyl radicals, in conformity with the photochemical primary process in the ultra-violet, namely[6]: $H_2O_2 + h\nu \rightarrow 2OH$.

It is clear that these effects are not confined to aqueous systems and may be of considerable importance whenever one is dealing with any two- or multi-component system, containing a relatively high proportion of solute molecules or other components with absorption bands extending farther towards the longer wave-length region of the spectrum than those of the solvent or of some of the other components.

It also follows that, in the study of the chemical action of ionizing radiations in solution, extrapolation, for example, from more or less concentrated aqueous solutions to the behaviour of water itself, is not permissible without due consideration of such 'direct' effects on the solute.

I wish to thank Prof. R. E. Peierls for many valuable discussions.

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Heats of Formation of Gaseous Fluoro- and Fluorochloro-Carbons

THE heat of formation of carbon tetrafluoride was determined by von Wartenberg[1] by measurement of the heat of combustion of potassium in the gas to form potassium fluoride and carbon. We have repeated his work and made similar measurements for several other fully halogenated fluoro-compounds, for which previous experimental determinations were lacking. The general technique used was the same as that of von Wartenberg—in particular, the reaction chamber was of the same size and design as his, and the reaction was likewise initiated by striking a d.c. arc between a graphite rod and a quantity of potassium, filtered from oxide, contained in a nickel crucible. The ignition energy was, however, measured more reliably by recording the arc current and voltage simultaneously on a moving film by means of a double-beam oscillograph. The calorimeter was of the isothermally jacketed type, with kerosene as the calorimetric fluid, the heat capacity being determined electrically.

To minimize errors due to pyrolysis, an excess of potassium was used with each gas. The amount which had reacted was determined by volumetric analysis of the aqueous extract of the solid residue for chloride and/or for fluoride. Although the potassium was manipulated in argon so far as possible, it was also necessary to determine the amount of carbonate in the residue, in order to apply a small correction for heat evolved in the reduction of potassium dioxide by carbon.

In deriving the heats of formation (ΔH_f) from the observed heats of reaction, the values taken for the heats of formation of potassium fluoride and chloride were respectively $-134{\cdot}5$ and $-104{\cdot}2$ kcal./mole[2]. Also, since the carbon produced in the reaction was found by X-ray diffraction to be highly amorphous (contrary to von Wartenberg's statement), an assumed enthalpy decrease of 2·5 kcal./gm. atom was allowed for the transition to graphite[3].

Table 1 gives a list of the average values for ΔH_f for each gas at 25° C., referred to the elements in their standard states. For comparison, the U.S. Bureau of Standards values[2] for the related hydrocarbons and chloro-compounds are included in the table, together with some values derived from recently published heats of combustion of the chloro-compounds[4] (all referring to the gaseous state at 25° C.).

Apart from the case of fluorotrichloromethane, the reproducibility of the results was satisfactory;

Table 1

Fluoro-compound	ΔHf, kcal./mole	Related compounds	ΔHf, kcal./mole Ref. 2	Ref. 4
CF_4	− 218 ± 2*	CH_4	− 17·89	—
CF_3Cl	− 171 ± 1	CH_3Cl	− 19·58	—
CF_2Cl_2	− 112 ± 2	CH_2Cl_2	− 21	− 22·3
$CFCl_3$	− 70 ± 4	$CHCl_3$	− 24	− 25·0
		CCl_4	− 25·5	− 22·2
C_2F_4	− 303 ± 2	C_2H_4	− 20·24	—
$(CF_2Cl)_2$	− 213 ± 3	$(CH_2Cl)_2$	− 32	− 30·3
		C_2Cl_4	− 34	− 35·4
C_2F_4	− 162 ± 1	C_2H_4	+ 12·5	—
CF_2 : $CFCl$	− 126 ± 2	CH_2 : $CHCl$	+ 7·5	—
		C_2Cl_4	+ 6	− 3·6

* Cf. von Wartenberg's value, − 231 ± 3 kcal./mole ≡ − 229 kcal./mole when corrected to graphite.

but it is known that they are affected by several errors small in amount though difficult to evaluate; for example, the solid residues after combustion liberated small amounts of acetylene and olefin on treatment with aqueous alcohol, and in several cases the reaction vessel after the combustion was found by mass-spectrographic analysis to contain traces of gaseous fluoro-compounds other than the one under test. An indication that our results are accurate at least within 10 kcal./mole is that, according to the table, the heat evolved in the reaction $C_2F_4 + Cl_2 \rightarrow (CF_2Cl)_2$ should be 51 kcal./mole, whereas Lacher *et al.*[5] by direct measurement found 57·3 kcal./mole (accuracy 1–2 per cent). It may be noted also that the increments in ΔH_f for the replacement of a fluorine atom by a hydrogen atom are within the range (41–52 kcal./mole) which can be inferred from Swarts's measurements of the heats of combustion of various partially fluorinated organic compounds[6].

According to the above results, the C—C and C=C bond-energies in the fluoroethanes and fluoroethylenes tested must be considerably less than in ethane and ethylene respectively, if the C—F linkages have the same average energy as in CF_4.

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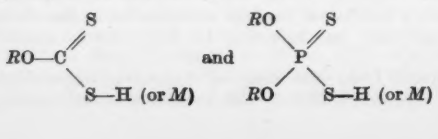
Adsorption of Alkyl Xanthate and Dithiophosphate on a Cleavage Face of Galena as revealed by Electron Diffraction

Xanthates and dithiophosphate are the two principal collecting reagents in the flotation for sulphide minerals. They have structural formulæ



respectively, where R is an alkyl group and M an alkali metal or ammonium ion. It is generally accepted that the alkyl group may be standing upright on the mineral surface.

One of us has studied the interactions of alkyl xanthate solutions with both fresh and oxidized galena cleavage faces by electron diffraction[1] (galena: PbS, NaCl-type cubic[2] with $a = 5{\cdot}92$ A.; cleavage face, {100}). With the latter faces the main interaction was the attachment to the surfaces attacked of the precipitated lead xanthate crystallites in fibre orientations[3]. With the former faces, including the slightly oxidized ones, the electron diffraction pattern shown in Fig. 1 was obtained with 100- or 500-mgm./l. solutions. It consisted of diffuse vertical streaks situated on vertically elongated galena spots at any azimuthal setting of the crystal to the electron beams. The pattern gradually changed into two haloes within a few days in air. The streak pattern was interpreted as due to monomolecular patches, presumably of xanthic acid, adsorbed on the sites of the lead atoms of the galena lattice[1]. With this mode of adsorption (Fig. 3*a*) the area occupied by an adsorbate on the galena face is $(5{\cdot}92 \text{ A.})^2 \div 2 = 17{\cdot}5 \text{ A.}^2$, a value very near the cross-section of an alkyl group in a solid paraffin[4], namely, $18{\cdot}5 \text{ A.}^2$.

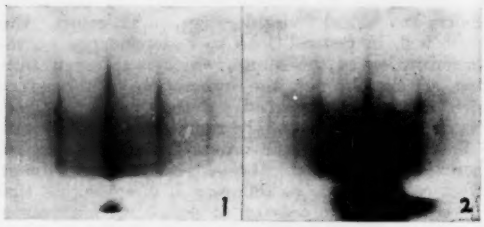


Fig. 1. A diffuse streak pattern obtained on a slightly oxidized galena cleavage face after reaction with aqueous *n*-butyl xanthate, 100 mgm./l.; beam parallel to cube edge

Fig. 2. A diffuse streak pattern obtained on fresh galena cleavage face after reaction with aqueous diethyl dithiophosphate, 10 mgm./l.; beam parallel to cube edge

With alkyl dithiophosphate, however, this mode of adsorption would not be expected, since the cross-section of its anion or its acid molecule may be approximately twice as large as the xanthate anion or xanthic acid molecule. In order to throw light on this problem, an electron diffraction investigation has been carried out on the interactions between a fresh galena cleavage face and diethyl dithiophosphate solutions in distilled water. The crystal specimen was 2 mm. × 2 mm. × 1 mm. in size, and 10 c.c. of the interacting solution was used in every case. The reaction time and temperature were 10 min. and 20° C., respectively.

With a 10-mgm./l. solution, a diffraction pattern (Fig. 2) was obtained three times out of six independent trials. Its characteristic feature was that, with the <100> incidence of electrons to the specimen surface, vertical streaks were observed just in between and just over the Kirchner–Raether lines of the galena cleavage face. With the <110> incidence they were observed just over the Kirchner–Raether lines alone. In the remaining three cases the streaks were weaker in intensity and the pattern as a whole resembled the cleavage pattern closely. With 20- or 5-mgm./l. solutions the streaks were still weaker. With solutions of concentration more than 20 mgm./l. or less than 5 mgm./l. they were not observed at all.

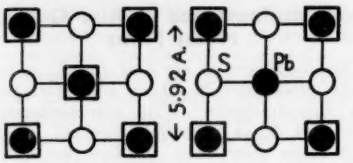


Fig. 3. Schematic representation of the mode of adsorption on galena face of xanthate (*a*), and dithiophosphate (*b*). Adsorbates are represented by squares

The interpretation of the present streak pattern may be that diethyl dithiophosphate, whether as acid molecule or as anion, has been adsorbed on the galena lattice with a mode drawn schematically in Fig. 3*b*. In this adsorption, lead atoms at the sites of the next nearest neighbours of any occupied lead atom on the galena face are occupied by the adsorbates. As compared with the case of xanthate (Fig. 3*a*) the area occupied by an adsorbate is twice as large in the present case. This may be attributable to the supposed difference in the areas of the cross-sections of dithiophosphate and xanthate, the former being twice as large as the latter.

That the present streaks were not due to surface anomalies of the cleavage face itself was shown by examining a number of randomly selected cleavage samples from the same crystal block from which specimens for the study of adsorption were obtained. In no instance was a diffraction pattern like that represented in Fig. 2 obtained from any portion of the cleavage faces. By the mere soaking of the cleavage face in distilled water containing no dithiophosphate but under otherwise the same experimental conditions, the present streak pattern was not obtained at all. Further details of this work, including interactions with oxidized surfaces, will be published elsewhere.

We are grateful to Mr. Sakano and Mr. Hosoi, of Mitsubishi Metal Mining and Metallurgical Laboratory, for the preparation of the reagents.

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Occurrence of μ-$CaCO_3$ in Boiler Scale

During small-scale experiments at the Fuel Research Station on the effect of treatment of boiler feed-water on the structure of boiler scales, several deposits were examined by X-ray diffraction. Most of the deposits contained calcium carbonate as calcite and calcium sulphate as anhydrite. In the deposit from one of the experimental boilers, the bulk of the carbonate, however, occurred as the rather unusual hexagonal form, μ-$CaCO_3$ or vaterite. This overlay a thin band of calcite. It is believed that this is the first occasion on which μ-$CaCO_3$ has been reported in such deposits.

There were no notable differences between the conditions of operation of the boilers producing a deposit of a normal type and those producing the deposit containing μ-$CaCO_3$. Periodic analyses of the feed-waters to the boilers showed no appreciable differences in the quantities of calcium, magnesium, sulphate, silicate, total dissolved solids, total hardness, or hydrogen ion concentration. It has not been found possible to explain the presence of this unusual type of carbonate deposit as due to variations in the main characteristics of the feed water, or in the conditions of operation of the boilers.

The occurrence of μ-$CaCO_3$, which is reported to be more soluble than calcite, agrees, however, with the decrease that was recorded in the total weight of the deposit in the boiler, and the accompanying increase in the dissolved solids in the water removed from the boiler. It would follow that while the μ-$CaCO_3$ was being deposited, the boiler water must have been supersaturated with respect to calcite. It is possible that this was caused by the fortuitous appearance in the feed-water of a substance or substances that repress the crystallization of the less-soluble forms of the carbonate. Samples of the feed-water to the various boilers were not examined for their minor constituents; but a comparative spectrographic analysis of the carbonate deposits gave results that were of interest. The most notable differences were that the deposits containing μ-$CaCO_3$ held larger quantities of lead, and smaller quantities of strontium, magnesium and silicon, than those which contained mainly calcite. There was no apparent difference in the phosphorus content of the two types of deposit.

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Influence of 'Surface Chilling' on the Detonative Behaviour of Cast Trinitrotoluene

In an earlier communication[1], attention was directed to the influence of charge-cooling conditions on the detonation velocity of cast T.N.T. Since this effect is of considerable interest by virtue of its bearing on the various theories put forward to account for the initiation of the explosive decomposition at the shock wave front, and because of its importance in connexion with the study of marginal confinement effects in cast explosives, the following examples of its operation are presented.

Charge casings of lead, copper and steel were employed. The degree of 'surface chilling' was varied by heating the charge-casing prior to pouring in the molten T.N.T., and in one case further variation was obtained by slower cooling of the charge after casting. Special casting techniques were employed in order to avoid cavitation of the cast charges. The velocities of detonation obtained using the Dautriche method[2] are recorded in Table 1. The degree of confinement S expresses the number of grams of metal per sq. cm. of charge surface.

Table 1

Confining metal	Casing temp. (° C.)	S (gm./sq. cm.)	Density (gm./c.c.)	Mean velocity of detonation (m./sec.)
Lead	20	6·6	1·60	6,820
	70	6·6	1·57	6,430
Steel	20	2·2	1·59	6,760
	83	2·2	1·57	6,480
Copper	20	3·3	1·58	6,795
	57	3·3	1·57	6,580
	90*	3·3	1·56	5,900

* Slower rate of cooling after casting

The velocity of detonation of cast T.N.T. under conditions of heavy confinement is therefore very dependent on the charge-casing temperature prior to filling and on the subsequent rate of cooling. In the usual method of casting into cold casings, the initial cooling at the periphery of the charge is very rapid by reason of the high heat capacity and thermal conductivity of the metal casing producing a finely crystalline peripheral layer.

Up to the present, the prevalent idea has been that conditions at the centre of the charge mainly determine the detonation velocity. While this may be the case in theoretical treatments involving the assumption of uniform charges, in practice, when dealing with cast charges where complete uniformity is difficult or impossible to obtain, it would appear to be the conditions existing at the surface of the charge which are the more important.

Thus, some workers, by a comparison of the detonation velocities of comparably confined charges using ordinary 'clear cast' and 'creamed T.N.T.' in which the crystal size was reduced by stirring while solidification was occurring, observed no significant difference and concluded that changes in grain size were without effect on the detonation velocity. This observation may be accounted for by the production of the finely crystalline peripheral layer as indicated above, so that further reduction in the crystal size of the interior of the charge has very little additional effect. Many other reported cases of 'anomalous' detonative behaviour in cast T.N.T. charges may be similarly explained in terms of different surface cooling-rates.

Similarly, in investigations on the influence of different types of metallic confinement on the detonation velocity of cast charges, the influence of the thermal properties of the casing also requires consideration, since they may introduce differences into the crystalline character of the charge periphery. If the appreciable differences in the thermal properties of the materials normally employed in this kind of work are considered, it would appear that this factor might often assume significant proportions. It has, however, so far received little attention.

The present experimental results serve to emphasize the importance of accurate crystallographic control in all work with cast explosives.

I wish to thank the Chief Scientist, Ministry of Supply, for permission to publish these results.

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Cathodoluminescence of Air, Quartz and Metal Films

The luminescence of air and fused quartz under α-particle irradiation has been observed previously using a photomultiplier[1]. The luminescence spectra of these and other materials excited by 100-keV. electrons have now been studied with a quartz spectrograph. The electron beam was obtained from a discharge tube, fitted with a metal Lenard window, the specimens being placed in external contact with the window. This method of exciting 'scintillation' spectra is advantageous since the specimens can be readily inserted, the luminescence is much more intense than that excited by the α-particle sources used by other observers[2,3] and the self-luminosity of such sources[1,4] is eliminated.

The cathodoluminescence spectrum of air consists of a series of lines in the visible and near ultra-violet, similar to that excited by polonium-210 α-particles[2-4]. The spectrum of fused quartz consists of a continuum in the same spectral region. The quartz exhibits phosphorescence which persists for several minutes after the irradiation and is similar to that observed from fused quartz envelopes of hydrogen and mercury discharge lamps[5,6]. The superimposed air and quartz spectra, recorded when the quartz plate was separated from the Lenard window by a thin air layer, are reproduced in Fig. 1*a*. Fig. 1*b* shows the calibration mercury discharge spectrum.

Other observers[3,7] have reported luminescence of thin metal films bombarded by α-particles. An attempt has therefore been made to observe the similar light emission to be expected under intense electron bombardment, using thin foils of gold, silver, aluminium and tin. No luminescence of the metal foils has been found. When the metal foil was mounted on a quartz plate, the spectrum observed was identical with that from the quartz alone, apart from the reduction in intensity due to the incident energy dissipated in the foil. When the metal foil was mounted in air, the spectrum observed was identical with that from the air alone. In each case no luminescence was found unless the electron beam penetrated into the medium (quartz or air) beyond the foil.

These results suggest strongly that the previous observers[3,7] have been in error in attributing luminescence effects to thin metal and other films, due to their neglect of the luminescence from the air or from the quartz plates on which the specimens were usually deposited. A careful examination of their reports is fully consistent with this hypothesis.

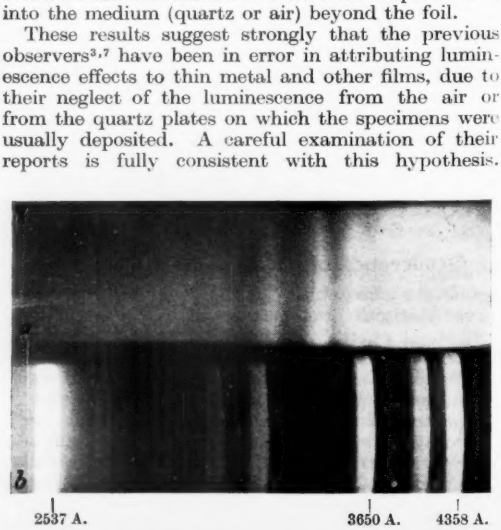

Fig. 1. *a*, Spectra of air and quartz; *b*, calibration mercury discharge spectrum

Richards and Cole[7] find that the thin-film 'luminescence' disappears when the α-particles are just unable to penetrate the film into the medium beyond (air). The 'luminescence spectra' of the aluminium, copper and gold films recorded by Norman *et al.*[3] appear identical with that of the quartz plate on which they were deposited. The latter can be seen clearly in the gap between two metal films on one of their photographs (spectrum *d*).

It is concluded that there is, as yet, no satisfactory evidence for light emission from thin films of metals and other 'non-luminescent' materials excited by ionizing radiation. A similar conclusion was drawn previously from the photomultiplier studies using α-particle irradiation[1].

One of us (W. A. L.) wishes to acknowledge his thanks to the South African C.S.I.R. for a research bursary and grant.

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Automatic Particle-sizing by Successive Counting

The development of automatic apparatus, generally employing optical scanning systems in conjunction with electronic counters, for determining the number and size of a population of small particles randomly dispersed in one plane has aroused considerable interest during recent years. Walton[1] has summarized some of the chief trends and methods used in the design and operation of such apparatus. Hawksley[2] has pointed out that, whereas counting can be carried out by relatively simple instruments, all proposals for methods of size determination have involved the measurement of pulse-heights or pulse-lengths from the records obtained from photoelectric scanning devices. He showed, however, that it is possible to derive a value for the mean diameter of the particles from a series of counts made with scanning spots of different sizes, so that sizing can be carried out with simple counting apparatus. He also implies that similar results could be obtained if the 'response-level' of the detecting device is altered during successive counts, but fails to follow up this suggestion.

In the course of designing an apparatus for the automatic counting of neps (small tufts of entangled fibres) in carded webs, we find that we have unconsciously elaborated Hawksley's suggestion, and

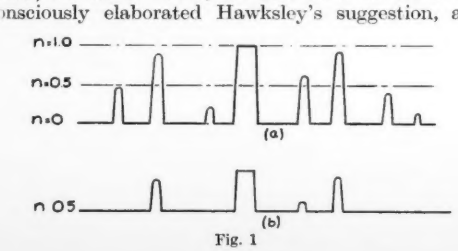

Fig. 1

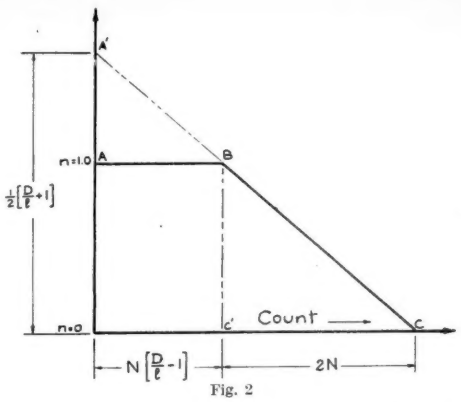

Fig. 2

as the technique involved is much simpler than that involving quantitative variation of the size of small scanning spots, it may prove to be of general interest.

The apparatus mentioned consists of two plate-glass disks 14 in. in diameter, between which the specimen to be examined is sandwiched. The disks rotate at fixed speed (30 rev./min.) and the area of the sample is scanned in spiral fashion by a photoelectric scanning head of the usual pattern moved by a lead-screw along a radius of the disks. The photocell output, after suitable linear amplification, is modified in the following manner before being fed to an electronic counter of conventional type.

In the ideal case, in which the sample scanned consists of a series of opaque circular spots on a uniformly transparent or translucent background, the amplified photocell output consists of a series of positive-going voltage pulses of varying heights, as shown in Fig. 1*a*. The smaller pulses are due to partial cut-off of the light by a particle, the highest ones to complete cut-off, and if the size of the scanning spot is small compared with the diameter of the largest particle, many of the particles will produce more than one pulse, so that the pulse number is in general greater than the total number of particles. This amplified signal is fed to a biased diode clipping circuit, which permits only pulses exceeding a certain amplitude to be passed on to the counter. The level at which clipping occurs is variable by adjustment of the diode bias, and is designated as n, varying from 0 to 1. At $n = 0$, no clipping occurs; at $n = 1$, the highest pulse is just clipped out, and no counts are registered. Fig. 1*b* shows, for example, the signal passed to the counter when $n = 0{\cdot}5$ in the case of the input signal shown at Fig. 1*a*.

It may easily be shown that

$$\frac{C}{N} = \frac{L + D - 2nL}{d + \mathrm{L}},$$

where C is the total counts registered by the counter; N is the total number of particles present; D is the average diameter of the particles; n is the clipping level as defined above; L is the width of the scanned track (at right angles to the direction of scan); d is the width of the unscanned track left between adjacent scanned tracks.

This relation is subject to two assumptions, namely, (*a*) L is less than the diameter of the smallest particle present; (*b*) D is negligible compared with the total width of field scanned.

If the width of the scanning track and the pitch of the scan spiral are adjusted so that $d = 0$ (that is,

Fig. 3

the whole of the field is scanned, and not just part of it), then

$$C = N\left(1 + \frac{D}{L} - 2n\right).$$

Plotting the experimental count C against the clipping-level n results in a curve similar to the line ABC in Fig. 2. Here $AB = OC^1 = N\left[\frac{D}{L} - 1\right]$, $C^1C = 2N$, and if CB is produced to cut the n-axis at A^1, then $OA^1 = \frac{1}{2}\left[\frac{D}{L} + 1\right]$. Hence, by counting the specimen at successively increasing values of n and plotting the resulting relation, both the number of particles and their average diameter may, in theory, be determined.

Experimental tests carried out on 'ideal' specimens consisting of small punched cardboard disks of known diameter randomly distributed between the glass disks and scanned and counted in the manner described fully confirm the mathematical theorem. Fig. 3 shows a plot of a typical run, superimposed on the expected relation. The agreement is very good except for some rounding of the corner at B, but this does not interfere with the use of the curve in the manner described above.

The following table summarizes the results obtained with four different arrays of particles, of which two consisted of mixtures of particles of different sizes.

Actual array tested			Experimental values obtained			
Details of array examined	N (total)	$\overline{D}$ (in.)	N (total)	$\overline{D}$ (in.)	% error of N	% error of D
100 of diam. 0·1 in.	100	0·100	101·1	0·098 (7)	+1·1	−1·3
30 of diam. 0·1 in.	30	0·100	29·5	0·100 (2)	−1·6	+0·2
30 of diam. 0·1 in. 30 of diam. 0·1275 in.	60	0·113 (7)	61·2	0·110 (8)	+2·0	−2·5
10 of diam. 0·084 in. 10 of diam. 0·100 in. 10 of diam. 0·1275 in.	30	0·104	29·1	0·104 (8)	−3·0	+0·8

Width of scan track = 0·05 in.; scanned at 20 lines/in. (Each experimental value is the mean of five determinations).

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Effect of Vapours of Halogen Compounds on the Emission of Positive Ions from Platinum

It was observed by C. W. Rice in 1944 that the emission of positive ions from a platinum anode heated in air is increased very markedly when vapours of compounds containing halogens such as carbon tetrachloride, chloroform, 'Freon', sulphur hexafluoride etc., strike the anode surface[1]. We have studied this phenomenon, the Rice effect, and obtained the following results.

(*a*) The positive ion current, once increased, falls off again to its original intensity even though vapour of the halogen compound is continually supplied; and as W. C. White[1] observed, the effect of the vapour reappears only after air alone has been admitted for some time. (As halogen compounds carbon tetrachloride, chloroform and methyl chloride were used and they all gave similar results.)

(*b*) The Rice effect can be observed as long as the inherent positive emission, usually the alkali ion, from the anode persists; and the anode that has been freed from the alkali ion emission by flashing and become unable to give rise to the Rice effect regains its ability if a slight amount of potassium or sodium chloride is applied to its surface.

(*c*) If a small amount of the vapour of a halogen compound is mixed for a few seconds at a time with the air current passing by the platinum wire anode, the Rice effect can be made to occur many times successively with ever-decreasing intensity until it is entirely suppressed by some sort of surface contamination. The total amount of positive ions thus produced may amount to about one and a half times the total amount of alkali ions emitted from a fresh piece of platinum wire of the same length heated in an air current until it ceases to emit. The latter amount has been found to be substantially the same for every piece of the wire tested and independent of the temperature of heating. (In the case of alkali ion emission from platinum at 1,300° K. in the presence of oxygen, the ratio of the number of positive ions to that of neutral atoms is, according to the Saha–Langmuir–Kingdon's equation, so large that the number of positive ions cannot be increased materially by any increase in the electronic work function as a result of the adsorption of halogen.)

(*d*) For the Rice effect to occur, the presence of air or oxygen is indispensable, because the positive ion emission from the platinum anode in vacuum, far from being increased, is actually decreased if the halogen compound vapour alone is admitted.

(*e*) In the absence of oxygen, carbon tetrachloride vapour produces a considerable negative emission which persists even after the complete removal of the vapour; details of this effect will be reported in due course.

(*f*) The platinum anode surface on which the Rice effect has just taken place shows a 'leopard-skin' pattern, presumably of carbon deposited from the halogen compound, and becomes mossy in a few days at room temperature in vacuum or in air. If the Rice effect has not occurred, due to the absence of oxygen or alkalis or to some unknown causes, the platinum surface looks clean at first but becomes mossy as in the previous cases.

(*g*) Platinum as incandescent anode material is not essential to the Rice effect. Other oxidation-resisting materials such as nichrome can also be used.

W. C. White[2] considers that halogen 'speeds up' the formation of alkali positive ions from alkali neutral atoms, for it has the highest electron affinity among the elements. His assumption is, however, contrary to the effects in paragraphs *c* and *d*.

We are rather inclined to assume that the Rice effect may be due to the production of some new species of positive ions in some way by a surface reaction between oxygen and vapours of halogen compounds which seems to be related to the presence of alkali ions.

The Rice effect is a significant observation in the field of positive ion emission, and the present work is now being continued in an attempt to find a clue to the study of some aspects in heterogeneous catalysis in gaseous reactions.

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Effect of Shoot Orientation on Leaf and Shoot Development

Factors influencing leaf shape are listed by Ashby[1] and include light intensity, length of day, mineral content of the soil and water supply. In the course of research on the behaviour of the rhizome of *Agropyron repens*, it was found that the form of the growing leaves and also the development of the rhizome was markedly affected when the orientation of the rhizome was changed, so that the gravitational force acted along the shoot in a basipetal direction instead of across it. Direction of gravity as a factor controlling leaf shape does not appear to have been reported previously.

One of the problems to be solved concerning the development of rhizomes is to elucidate the causes which eventually transform the tip of the subterranean rhizome into an orthotropic aerial shoot after a period of rhizome growth. In *A. repens* it was observed that aerial shoot formation is preceded by a change in the response of the rhizome to gravity, the tip becoming negatively geotropic and curving up into the vertical position. The change of shoot form which follows is marked by the replacement of the scale-leaves of the rhizome by a transitional series of leaves and ultimately by aerial foliage leaves.

It was found that the rhizome of *A. repens* could be induced to change prematurely into an aerial shoot, with the accompanying change of leaf form, by placing the rhizome tip so that it pointed vertically upwards. This was done with a number of young rhizomes, and it was found that the complete change generally took ten days. The first transitional leaf appeared after 4 or 5 days. As the rhizome terminal bud contains 4–5 developing leaves which emerge at 2–3 day intervals, it follows that the transitional leaves at least are formed by the modification of growing leaves which would normally have developed into scale-leaves.

This change could not be induced by placing the rhizome tip so that it was pointing vertically downwards. It is therefore clear that it is caused by gravity acting in a basipetal direction along the length of the rhizome, and is not a response to the multilateral stimulus of gravity. This was confirmed by the fact that detached rhizomes, which showed a similar behaviour to attached ones, did not change into aerial shoots when rotated on a klinostat in the horizontal plane about their long axes. The change from a rhizome to an aerial shoot in *A. repens* therefore seems to be the result of the fact that at the end of the summer the rhizome tip curves round so that it points upwards.

Further experiments revealed the fact that, while in the transitional state, young attached shoots could be made to revert to forming rhizome tissue again by returning the shoots to the horizontal position. When this was done, a series of leaves showing a transition in form back to the scale-leaf appeared. When first returned to the horizontal position, the shoots showed a strong negative geotropism, necessitating frequent adjustment to keep the shoot horizontal. This tendency disappeared as the rhizome form was resumed. Mature aerial shoots could not be made to revert to the rhizome form, suggesting that in the vertical position the course of development of the shoot apex eventually becomes permanently changed so that it can form only the organs of the aerial shoot.

These experiments have been repeated using the rhizome of *Sporobolus virginicus*, a common grass on the sandy beaches of the Caribbean. Similar results were obtained, though the response to change in position of the shoot was much slower than in *Agropyron repens*.

It is therefore apparent that in these two grasses the plagiotropic tendency shown by the rhizome serves not only to keep it below the soil surface, but also to preserve the form of the rhizome by preventing the development of aerial shoot organs.

Part of this work was carried out in the University of Sheffield, during the tenure of an award from the Department of Scientific and Industrial Research.

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Influence of Leaf Activity on the Composition of the Wood Cell Wall

Nearly twenty years ago, Clarke[1] discovered a relationship between fibre wall composition, as revealed by botanical lignin reagents, and the variation in strength of home-grown ash (*Fraxinus excelsior*) timber. His subsequent observations on some three hundred other hardwoods demonstrated the wide application of this relationship and at the same time brought to light a marked difference between temperate and tropical species[2]. The latter were found to be more resistant to compression along the grain but weaker in impact bending-strength than the temperate hardwoods on a weight-for-weight basis; they also showed a much stronger reaction with the traditional lignin reagents. Comparison of timber grown in the tropics with that of the same or closely allied species grown under temperate conditions indicated that the kind of lignin reaction must be related to a geographical or climatic factor and not to generic constitution.

Recently, evidence has been found that the controlling factor in lignification (in the botanical sense) of the fibre walls is the illumination received by the leaves. The hypothesis originated during a survey of the variation in lignification of English ash, when it was noticed that the spring-wood zone of each annual ring consistently gave a poor lignin reaction irrespective of the degree of lignification in the remainder of the ring. It is known from previous work[3] that the spring-wood in ash is formed before the leaves have expanded, and this now suggested that whereas starch, or other stored food material, already present in the stem can suffice for cambial growth, lignification of the new fibres is dependent on some product associated with leaf activity. Further substance was given to the hypothesis by the observation that the spring-wood in the annual ring of wood next to the pith, by contrast with the spring-wood in subsequent rings, showed good lignification: this first annual ring corresponds with the terminal shoot, in which leaf development from the terminal bud precedes wood development.

Confirmatory evidence for the hypothesis was obtained from the following pilot experiment. A hood was placed over the upper portion of a coppice shoot of ash early in May 1953, shortly after the buds had burst and the leaves were no more than 2 in. long. A fortnight later, the hood was removed and the etiolated leaves exposed to normal illumination for a month. The hood was then replaced for another three weeks and finally removed in mid-July. Transverse sections, 12 μ thick, were taken at intervals along this stem and stained with safranine followed by fast green. These showed that the 1953 growth-ring in the hooded portion of the stem contained alternate zones of unlignified and lignified fibres corresponding respectively with the alternating periods of hooding and exposure of the leaves to light (Fig. 1). A control stem growing from the same stool, on the other hand, showed the usual pattern of lignin reactions, the 1953 extension shoot being lignified throughout, whereas the increment around the 1952 shoot was poorly lignified in the spring-wood and well lignified in the summer-wood.

In view of the observations recorded above, it seems reasonable to attribute the greater lignification of tropical timbers to the exposure of the tree crowns to more adequate solar illumination in the tropics.

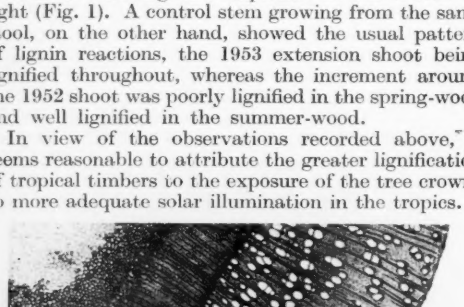

Fig. 1. Transverse section of experimental shoot of ash taken near tip of 1952 growth. Stained safranine and fast green; photographed with green filter. The red-stained, lignified tissues appear darker than the poorly lignified (green-staining) portions. The 1952 growth-ring formed under normal illumination is well lignified throughout. In the 1953 ring the dark zones (*a*) correspond with periods when the shoot was exposed to normal sunlight, and the lighter zones (*b*) to periods when it was hooded. × 12

These findings point the way to research which may lead to a better understanding of the mechanism of woody growth. They should also give more precise direction to the investigation of relationships between environmental factors and timber quality, investigations which have been handicapped in the past, not only by the difficulty of distinguishing the effects of the various environmental factors, but also by the lack of any specific knowledge of the physiological mechanism through which such factors operate.

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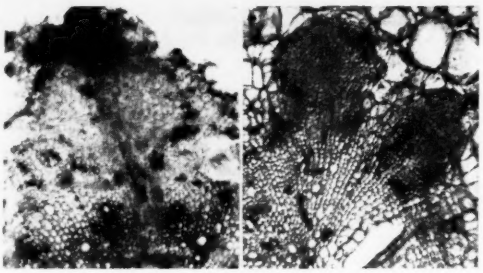
Adventitious-Root Formation by Fungal Pathogen Metabolites as a Possible Mechanism of Disease Resistance

In a previous paper[1] it was demonstrated that adventitious-root formation, due to *Fusarium vasinfectum* metabolites, is confined to the wilt-resistant 'Ashmouni' cotton cut shoots, while the susceptible 'Giza 26' cotton variety fails completely to initiate any root development. The comparative readiness of a resistant variety to form adventitious roots in response to the metabolites of the specific fungal pathogen on host extract, and the failure of a susceptible variety to manifest such response, have been further tested and verified with other species of *Fusarium* as well as cotton and tomato varieties. The present work has been carried out in an attempt to elucidate the two following problems: (*a*) the metabolitic potentialities of *Fusarium solani* (cf. Snyder and Hansen) to stimulate adventitious roots in wilt-resistant 'Karnak' and susceptible 'Giza 26' cotton varieties, and (*b*) the metabolitic potentialities of two tomato-wilt *Fusarium* species, namely, *F. oxysporum* and *F. moniliforme*, to initiate adventitious roots in wilt-resistant 'Myco. 1' and susceptible 'North Dakota' tomato varieties.

Cotton cut shoots. Aqueous extracts, from two-week old 'Karnak' or 'Giza 26' cotton seedlings, were prepared and each extract was divided into two portions: one portion was autoclaved and the other cold-sterilized by Menon's technique[2]. *Fusarium solani* was grown on these differently treated extracts, at 30° C. for 28 days, and the resulting fungal filtrate was further subdivided into two lots: one lot was left unheated and the other boiled for 15 min. Fresh healthy cut shoots, from four-week old 'Karnak' or 'Giza 26' cotton seedlings, were then inserted into differently treated filtrates. Control experiments were also made with either sterilized water or unconsumed seedling extract as the dipped medium. The treated cut shoots were left at ordinary laboratory temperature and examined regularly.

Unheated *Fusarium* metabolites, on cold-sterilized 'Karnak' seedling extract, have proved to induce adventitious-root formation in cut shoots of the same cotton variety; the interfascicular cambium (opposite the primary medullary rays) is stimulated to divide actively and produces a mass of meristematic cells, which become later differentiated into an adventitious root (Fig. 1*a*). On the other hand, *Fusarium* meta-



(*a*) (*b*)

Fig. 1. Transverse sections in treated cut shoots of: (*a*) 'Karnak' cotton variety in response to *Fusarium solani* metabolites (× 80): (*b*) 'Myco. 1' tomato variety in response to *Fusarium moniliforme* metabolites (× 65)

bolites on 'Giza 26' extract fail completely to induce any root initiation in its own cut shoots. The restriction of adventitious-root formation to *Fusarium* metabolitic potentiality on 'Karnak' extract, and its failure to produce such growth factor on the susceptible 'Giza 26' extract, have been further emphasized by similar cut-shoot experiments with different tomato varieties.

Tomato cut shoots. Cut shoots—from either the susceptible 'North Dakota' or the relatively resistant 'Myco. 1' tomato variety—were tested for their potentialities to produce adventitious roots in response to metabolites of two tested pathogenic Fusaria species (namely, *Fusarium oxysporum* and *Fusarium moniliforme*) on differently treated tomato extracts. 'Myco. 1' cut shoots were induced for adventitious-root formation in response to *Fusarium* metabolites (Fig. 1*b*); root initiation starts at an early stage, and the induced adventitious roots could soon be detected macroscopically. On the other hand, no detectable adventitious roots were observed in response to the insertion of the susceptible 'North Dakota' tomato cut shoots into *Fusarium* metabolites on their own extract. The thermostability of the growth metabolitic factor, responsible for root stimulation in 'Myco. 1' cut shoots, has been demonstrated by the comparable stimulatory effect of both autoclaved and cold-sterilized *Fusarium* metabolites.

The differential responses of host varieties to fungal pathogen metabolites, as demonstrated by the readiness of a resistant variety or the failure of a susceptible one to develop adventitious roots, might indicate that the initial fungal penetration—which has been proved to take place in both resistant and susceptible varieties—exerts an influence on the host vigour to some extent. The detection of a metabolitic growth factor in a resistant variety—as manifested by adventitious-root formation—might contribute to its resistance by: (*a*) the toxic effect of the fungal wilt-inducing metabolite is partially or completely eliminated by the opposing action of the associated metabolitic growth factor, and (*b*) the physiological function of the susceptible-variety roots ceases, either partially or completely, due to fungal infection and interference. On the other hand, induced adventitious roots—due to fungal metabolitic potentiality—enable the resistant variety to compensate for the physiological disturbance imposed upon the original infected primary roots and result in either postponing or interfering with the manifestation of the wilt symptoms. The further significance of this mechanism of disease resistance, and the elucidation of either one or the other of the two suggested possibilities, still require further investigation.

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A Colour Test for detecting Swollen Shoot Disease in Gold Coast Cacao

Hancock[1] reported a colour test for diagnosing swollen shoot disease in *Theobroma cacao* L.; the method consists of treating transverse stem sections with acidified methyl alcohol; but as the results require statistical analysis, it is of little practical value. Later, Lindner, Kirkpatrick and Weeks[2] described a staining technique for detecting viruses in the leaves of woody plants which involves extracting chlorophyll from the leaves and producing a colour reaction in the cleared leaves using normal sodium hydroxide and lactic acid.

The method of Lindner *et al.* failed to give definite indications of virus infections in cacao; but a modified technique using expressed sap has proved successful. 10 gm. of mature leaves, selected at random from all parts of the plant, are macerated with 25 ml. of distilled water and squeezed through muslin; 2 ml. of the extract is then heated to boiling point with an equal volume of normal sodium hydroxide. It is preferable to clarify the cooled samples by centrifuging at 8,000 r.p.m. for 2 min. The supernatant liquids are then made up to 6 ml. by the addition of further normal sodium hydroxide.

The colours developed are variable; but provided that strictly comparable leaf material from healthy trees of the same age and type as those under test is used as a control, infections can be diagnosed before any external symptoms are produced on the growing plant. Infected leaves produce a red-brown to crimson colour, and healthy leaves lime-green to greenish-brown.

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Chlorophyll in Young Shoots of European Beech (*Fagus sylvatica*) in Winter

Chlorophyll *a* and *b* has been observed in the xylem rays and in the pith in young shoots of *Fagus sylvatica* and several other species of trees including *Populus*, *Alnus* and *Betula*. The chlorophyll is localized in chloroplasts in cells rich in starch. The possibility of chlorophyll being stored in the cells of the pith and xylem rays in winter could not be excluded; but the transport of chlorophyll within the plant would have to be demonstrated.

Extracts were made from bark, buds and xylem of *Fagus sylvatica*, and concentrations of total chlorophyll and chlorophyll *a* and *b* separately were de-

CHLOROPHYLL IN *Fagus sylvatica*

	Chlorophyll *a* plus *b* (mgm.)			
	per 100 gm. of fresh weight	per 100 gm. of dry weight	per 50 cm.² surface	*a* : *b*
Xylem	17	35	—	1·3
Bark	47	72	0·5–1·2	3·5
Young leaves in buds	35	73	—	2·2

termined in a Coleman spectrophotometer. The pigments were separated by paper chromatography according to the method described by Sironval[1]. The results are summarized in the accompanying table.

The rather low ratio of chlorophyll *a* to *b* in the xylem is of interest; it ranges from 1·1 to 1·6 in different preparations, the average being 1·3. The lowest ratio previously found was 1·4 (submersal green algae). As only 2 per cent of the light passes through the bark layer of young twigs of *Fagus*, of course no photosynthesis could be expected to occur in the xylem.

Although the total chlorophyll concentration in the bark is low as compared with that determined in leaves of the same plant exposed to sunlight (770 mgm. chlorophyll *a* and *b* per 100 gm. dry weight, or 3·2 mgm. per 50 cm.² surface[2]) the ratio *a* : *b* of 3·5 corresponds to the ratio normally found in photosynthesizing tissue. This is not surprising, since the bark of trees in the light is known to resynthesize the carbon dioxide released by respiration of living cells in bark and xylem.

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Blood Groups of Human Blood Platelets

IN tables which they published recently, Stephanini and Plitman[1] described the existence of four blood groups in human blood platelets, while Harrington and his collaborators[2] describe the existence of eight such blood groups. Their research was based on the agglutination of platelets.

For our part, by absorbing anti-*A* and anti-*B* serums with highly concentrated suspensions of platelets, we were able to show the presence in these elements of the *A* and the *B* agglutinogens in persons belonging to the *A*, *B* or *AB* groups, while we found these antigens absent from platelets of the *O* type. However, such results were obtained only with platelet suspensions containing twenty million elements per c.mm., and after crushing these elements prior to the absorption of serums.

Controls were made with physiological liquid, serum and plasma, as well as with thick and thin suspensions of red cells, in order to prove that the absorption of antibody was not due to the presence of antigens dissolved in the serum or in the plasma, nor to the presence of red cells persisting in the platelet suspensions. The antibody absorbed by *A*, *B* or *AB* platelets is quite specific and sometimes reaches total absorption from the serums under study.

The serum, plasma and red cells used for the controls were always taken from the donor of the platelets.

Under these conditions, we conclude that: (1) human platelets do contain *A* and *B* antigens analogous to those of red cells; (2) these antigens seem to be located inside the protoplasm of platelets.

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Nutritional Availability of Cobaltic Oxide, Co_2O_3

SINCE Marston's pioneer work[1], numerous investigators have established that cobalt is an essential element in the nutrition of ruminants. Sheep and cows reared on diets low in cobalt (less than 0·1 mgm./100 lb. of body weight/day) lose their appetites, fail to gain weight, become anæmic, and finally become emaciated. The cobalt usually is added to the diet as cobalt chloride, cobalt sulphate, or cobalt carbonate, in a mineral feed or in a salt block.

The possibility of using the cheaper, but relatively insoluble, cobaltic oxide, as a cobalt source seemed attractive. To answer the question of whether the cobaltic oxide would provide the cobalt essential for ruminants, radioactive $^{60}Co_2O_3$, which was prepared in the United States Atomic Energy Commission piles at Oak Ridge, Tennessee, was fed to lambs. Three milligrams of cobaltic oxide containing 27 microcurie units of radioactivity per mgm. were fed daily to 75-lb. lambs for seven days. The animals were sacrificed on the eighth day. Muscle, blood and some of the internal organs were analysed for radioactivity with a scintillation counter. The results are presented in Table 1. In another experiment a lamb was given 10 mgm. of radioactive cobaltic oxide at a single feeding and the tissues assayed for radioactivity forty-eight hours later.

Table 1. CONCENTRATION OF COBALT-60 IN TISSUES OF LAMBS FED RADIOACTIVE COBALTIC OXIDE

Animal tissue	Cobalt-60 μgm./kgm. of wet tissue		
	1*	2*	3†
Blood	18	72	45
Liver	165	615	100
Heart	6	54	14
Lungs	25	150	12
Muscle	20	10	10
Spleen	68	100	80

* Animals fed 3 mgm. per day for 7 days.
† Animal fed one massive dose (10 mgm.) of radioactive cobaltic chloride.

The cobalt of cobaltic oxide was definitely absorbed and distributed throughout the body of the animal. The liver proved to be the site at which a large share of the radioactive cobalt-60 assimilated was concentrated. The results compare favourably with the work of Rothery, Bell and Spinks[2], who fed 50 μgm. and 500 μgm. of $^{60}CoCO_3$ to lambs daily over periods ranging from 90 to 123 days, and with the report of Comar and Davis[3], who studied metabolism of cobalt chloride in rabbits, swine and young calves. Approximately 80 per cent of the cobaltic oxide fed orally was found in the fæces, the other 20 per cent probably reacted with the hydrochloric acid in the digestive tract to form cobalt chloride, which then provided cobalt in a form that was readily utilized.

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Corpus allatum and Egg Production in Starved Milkweed Bugs

IN many insects, egg production requires special nutrition[1]. It has also been found, in most insects investigated, that the corpora allata are necessary for the normal function of the ovaries[2]. In the milkweed bug (*Oncopeltus fasciatus* (Dallas), Heteroptera, Lygaeidae), the ovaries of the female at the beginning of the adult stage are only slightly developed (Fig. 1*a*). When the female is kept in an incubator at 25° C. and fed on milkweed seeds and water, the ovaries may, after fifteen days, reach the size shown in Fig. 1*b*. Of fifteen females kept as described, nine had, at the age of fifteen days, already started oviposition, two more contained ripe eggs, while in four specimens the ovaries had only grown slightly. If the females are given only water and no seeds, they may survive for quite a long time, but no eggs are produced. After fifteen days, the size of the ovaries usually (ten specimens) is as shown in Fig. 1*c*, and only a slight growth has taken place.

At the same time, changes are observed in the incretory system. In the emerging female the corpus allatum is small (Fig. 1*a*, *ca*), but increases, as already shown by Novák[3], if she is fed. In the present material it increased to about twelve times the initial volume in fifteen days (Fig. 1*b*). In females given only water, the corpus allatum had, after fifteen days, increased only about 2·5 times (Fig. 1*c*). If the corpus allatum is transplanted from normally fed females in the oviposition period to females fed only on water, the latter will start egg production despite the lack of food. Of fourteen unfed females which thus received corpus allatum from fed females, eleven contained at later examination ripe eggs, two more showed a considerable growth of the ovaries, while only one specimen showed no reaction. Mostly two corpora allata were transplanted to each female, namely, at the age of five and ten days, and the specimen examined at the age of fifteen days; but when the transplantation was done only once, ripe eggs were still obtained. Fig. 1*d* shows the ovary of a fifteen-day old starved female which ten days earlier received the corpus allatum from a fed female. In most cases the corpus allatum was transplanted together with the corpora cardiaca and a fraction of the aorta. However, transplantation of only the posterior half of the corpus allatum with no traces of corpora cardiaca also resulted in egg development. When the females were kept alive for a sufficiently long period, they deposited eggs of normal size and shape. When the females were mated with normal males, the fertilized eggs developed to normal larvæ. In seven specimens muscles were transplanted as controls, but no changes in the ovaries were observed.

In the bug *Rhodnius*, also, fasting influenced both the corpus allatum and egg production[4], whereas in *Tribolium* and *Chrysopha* starvation prevented the normal development of the ovaries but not the growth of the corpora allata[5]. The two results of normal food supply, namely, growth of the corpus allatum and egg production, may in the milkweed bug be explained by presuming a primary influence on the corpus allatum, which then starts to function and secondarily induces egg development.

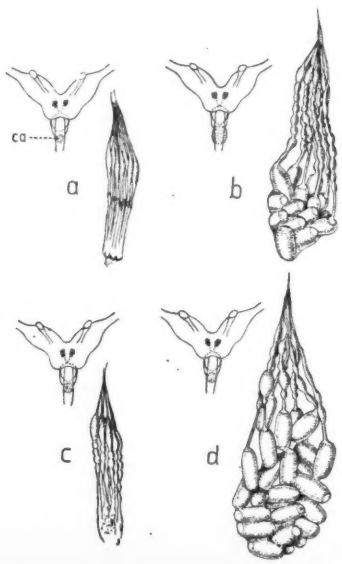

Fig. 1. The brain with the corpus allatum (*ca*) and the right ovary and lateral oviduct of females: (*a*) at the beginning of the adult stage; (*b*) 15 days old, fed; (*c*) 15 days old, starved; (*d*) starved, with corpus allatum transplanted from fed females

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Direct Observation of Hapten–Antibody Equilibria

IF the bivalency of antibodies, for which there is now considerable evidence, is accepted, it is to be expected that the addition of bivalent hapten to solutions of purified homologous antibody would bring about a linear association of alternating antibody and hapten molecules. The equilibrium extent of this association should be dictated solely by the value of the free energy of formation (ΔF^0) of a hapten–antibody bond and the concentration of the two reacting species. Hence a determination of the extent of association would provide the value of ΔF^0, and if this were done as a function of temperature the values of the entropy (ΔS^0) and the heat (ΔH^0) of bond formation would be available as well.

Light-scattering measurements on very dilute mixtures will yield the weight-average aggregate weight since the deviations due to non-ideal behaviour are negligible. The free energy of formation can be calculated in the following way. Let H_0 and A_0 be the initial concentrations of hapten groups and antibody sites respectively and p be the equilibrium fraction of hapten groups reacted. Then the equilibrium constant, K, for the reaction of a hapten group and an antibody site to form a hapten–antibody bond is given by

$$K = \frac{pH_0}{(1-p)\,H_0\,(A_0 - pH_0)}.$$

If the reactions are reversible, then equilibrium is established when the mixture is in its most probable state, and using the analysis of Goldberg[1] it can be shown that to a good approximation

$$\frac{M_w}{M_A} = \frac{1+p^2r}{1-p^2r},$$

where M_w is the weight-average aggregate weight, M_A is the molecular weight of the antibody, and $r = H_0/A_0$. Thus, from the measurement of the ratio M_w/M_A in a mixture of known concentration of hapten and antibody, p may be evaluated and K and hence ΔF^0 determined.

In addition to these expectations the dynamic character of the equilibrium should be reflected in the shift of the M_w/M_A ratio upon dilution and upon addition of further amounts of hapten or antibody. Moreover, the value of the ratio should approach unity upon the addition of monovalent hapten. Our observations on several purified antibody preparations using two haptens have verified these predictions and have permitted a determination of the thermodynamic quantities.

The systems studied have been rabbit antiarsanilic antibody, most of which was prepared by the method described by Campbell and Lanni[2], and terephthalanilide-*pp'*-diarsonic acid (T) and adipanilide-*pp'*-diarsonic acid (A). Some results are summarized in Table 1. Unless otherwise specified, the temperature is 25° C.

Table 1

Antibody Pool No.	Antibody conc. (gm./dl.)	Hapten	r	M_w/M_A	ΔF^0 (k.cal.)
IV	0·040	T	4·3	1·43	−7·59
		T	0·89	1·58	−7·58
		T	0·18	1·14	−7·52
		A	0·95	1·51	−7·49
		A	4·8	1·38	−7·55
X + XI	0·090	T	1·01	1·72	−7·44 (35° C.)
		T	1·01	1·90	−7·35
		T	1·01	2·02	−6·95 (5° C.)

From the results shown here and others the value of ΔF^0 is found to be $-7{\cdot}5 \pm 0{\cdot}1$ k.cal./mole of hapten–antibody bonds formed under the conditions *p*H 8·0 borate buffer, ionic strength 0·15 at the temperature 25° C. This average includes two haptens and different preparative procedures applied to two different antisera pools. At equimolar concentration of hapten and antibody, this means that 59 per cent of the antibody exists as 'monomer' (an antibody molecule combined with zero, one or two hapten molecules), 28 per cent as 'dimer', and 10 per cent as 'trimer', when the total antibody concentration is 0·04 gm./dl.

This result is in good agreement with the values obtained for a similar system by Eisen and Karush[3] and Lerman[4], who employed equilibrium dialysis measurements using monovalent haptens.

Applying the van 't Hoff relation to the K values determined at different temperatures, we obtain approximate values of $\Delta H^0 = -2{\cdot}4$ k.cal./mole (exothermic reaction) and $\Delta S^0 = +17$ e.u./mole. These values show that the entropy gain constitutes the major driving force of the reaction, and, as in the case of a similar observation for the association of insulin molecules[5], this suggests that water molecules are displaced from charged groups when the hapten–antibody bond forms.

In addition to the extension of the results summarized here, current work is concerned with the detection of heterogeneity of the bonds as might be displayed by deviations of plots of M_w/M_A versus concentration from the relation predicted for a single ΔF^0 value, the exploration of the rate of reaction and the extension of the method to acid solutions of specific precipitates.

This investigation is part of a study made possible by a grant from the Rockefeller Foundation. We greatly appreciate the help of Prof. W. C. Boyd (Boston University), particularly in the problem of antibody preparation, and expect to publish with him other aspects of this investigation in the near future.

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The Marshes of the Medway Estuary in Romano-British Times

J. P. T. Burchell (*Nature*, May 1, p. 832) appears to be taking a somewhat short-sighted view by denying the existence of an ancient pottery site on the Upchurch Marshes of the Medway Estuary.

Investigations carried out by us in recent years have shown that potting was at least one of the industries carried on in this region during the first and second centuries A.D. and probably also in the immediate pre-Christian era. This is borne out by the number of wasters (overbaked and distorted pots) found on the mud flats, the appearance of which precludes the possibility of importation from the opposite coast of Gallia Belgica. The absence of kilns has in the past been taken as evidence against the existence of potteries. We believe that the older, gritty wares, which fragment rather than warp on faulty firing, were fired on level ground under piles of straw and brush-wood, in the same way as many primitive native wares in modern Africa, which they resemble in type and material. Belgic terra nigra certainly blisters on faulty firing, and we have found numerous good examples. We have also excavated several structures which may well be kiln flues. It may also be significant that the modern Upchurch potteries, situated about five miles from the marsh, used, until quite recently, the local estuarine clay.

In view of Francis W. Reader's report of the Red Hills Exploration Committee[1], the possibility of salt-panning must be considered. It seems to us rather unlikely that this industry was carried out on the site in Roman times, since the water is now only brackish and loaded with silt, and we have biological evidence that the situation in the first and second centuries A.D. was similar, and indeed that the water may even have been less saline. We agree that the marshes were inundated, and by plotting the dates of finds we have been able to demonstrate the order in which various areas became covered by the sea. We fail to understand how any industry involving the use of fire could have been carried out on "the inter-tidal surface of the marsh clay" as Mr. Burchell suggests.

The Ordnance Survey maps of the area (6 in. : 1 mile) are misleading, in that they imply that the various sites occupy a very extensive tract, whereas, in fact, the occupation sites are of very limited extent and distributed along the banks of ancient creeks[2]. The structural remains are similar to those found on the foreshore of the Thames at Tilbury[3]. We believe that most of the finds have remained *in situ*, and that only in certain areas and in recent times have erosion and redeposition occurred, as evidenced by the distribution of waterworn sherds.

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Mr. J. P. T. Burchell, in *Nature* of May 1, p. 832, has made some statements on this subject with which I cannot agree. The archæological evidence obtained from the Upchurch Marshes over a period of nearly a century leaves no doubt that the area supported a flourishing potting industry throughout the first and into the early decades of the second century A.D. While there is little evidence to suggest an intensive occupation of the Milfordhope or Slay-hills Saltings after the Antonine era, there can be no denying that adjacent sites, notably at Otterham Creek, were inhabited and producing pottery well through the third century.

It would be unwise to be dogmatic with regard to the extent of the potting industry in the later Roman period; but it is certain that in the first century the output far exceeded local requirements. A few large storage jars have been traced to London, but it would seem that the bulk of the products were manufactured for distribution in the south-east of Britain, large numbers of vessels having, for example, been found at Richborough.

It does not follow that we can still accept the label 'Upchurch Ware' as referring to certain types of pottery. The Medway sites produced a wide variety of wares, the majority being common forms that were copied by potters up and down the country for so long as the shapes remained popular. It is therefore the fabric of the vessel rather than its form that may suggest the place of manufacture.

Mr. Burchell appears to base his archæological evidence on his Samian potters' stamps. It should be pointed out that the number of fragments of Terra Sigillata from the sites is minute compared with that of the coarse sherds. While it is true that most of the Samian fragments are of second century date, this fact cannot seriously be weighed against the overwhelming evidence of the other material.

The evidence on which the above statements are made is both long and complex and clearly cannot be discussed here. However, a research report is to be published in the next volume of *Archæologia Cantiana*. This, following Mr. John H. Evans's invaluable paper on the "Archæological Horizons in the North Kent Marshes" in the present issue of that journal, should do something to clarify an archæological problem that has too long remained unanswered.

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Classification of the Terrestrial Heteroptera (Geocorisae)

Following Dufour[1], the Heteroptera can be divided into three series: Geocorisae (land bugs), Hydrocorisae (water bugs) and Amphibicorisae (water-surface bugs). Reuter[2] divided the Heteroptera into seven series. One of these, Hydrobiotica, included most of the families of Dufour's Hydrocorisae and Amphibicorisae as well as Saldidae; the Geocorisae were split into five series, and the other series contained Corixidae only. China[3] followed Reuter with some modifications; he did not consider Geocorisae a homogeneous group. Börner[4] recognized three primary divisions of Geocorisae: Reduvioidea, Cimicoidea and Pentatomoidea. In the first he included Ochteridae, Saldidae and Enicocephalidae and in the last the Tingidae.

Recent work, carried out by us independently, together with some work by earlier authors, leads to the conclusion that most of the families of Geocorisae fall naturally into two groups; the evidence is as follows:

(1) Tullgren[5] erected a group, Trichophora, which included families from three of Reuter's series and the Piesmidae; hitherto the latter had been placed in a superfamily with the Tingidae. The group was characterized by the presence of ventral trichobothria and a basic type of pretarsal pseudoarolia (Tullgren's arolia). Although the Holarctic Aradids are without pseudoarolia, some New Zealand (Myers and China[6]) and Neotropical (Wygodzinsky[7]) species possess pseudoarolia with a basal sclerite, that is, of the Trichophoran type. Southwood finds a similar structure in *Aneurus*. (The term pseudoarolia is used here for the structures below the claws and does not imply homology with those of other orders or those of the Miridae).

(2) Singh-Pruthi[8] demonstrated the presence of two basic types of male genitalia in Heteroptera: a Pentatomoid type occurring in three of Reuter's series (Lygaeoidea and allies, Aradoidea, Pentatomoidea-Coreoidea) and in the Saldidae; a Reduvioid type occurring in the remaining bugs. Contrary to Singh-Pruthi, Leston finds the male genitalia of *Piesma*, and Southwood that of *Aneurus*, to be of Pentatomoid form.

(3) Leston, from a study of wing venation and areas, confirms Tullgren's Trichophora with the addition of Aradoidea, demonstrates the venational similarity of Tingidae and Reduviidae, shows two related patterns of venation in Reduvioidea and Cimicoidea respectively (including Joppeicidae within the latter) and places Ochteridae and Gelastocoridae in close relationship with Hydrocorisae. Preliminary studies suggest that the Saldidae possess modified Trichophoran venation; Enicocephalidae have a unique venation among land bugs suggesting only that of the wings of Hydrocorisae.

(4) Pendergrast, from a study of the female reproductive organs, concludes that the spermatheca of the Aradidae and Saldidae is of the same type as that found in most Trichophora (including Piesmidae). The spermathecæ of Tingidae do not show affinities with this group, but rather with those of Reduviidae and Phymatidae. Gelastocoridae and Ochteridae are clearly close to the Hydrocorisae.

(5) Leston[9,10] noted that eggs of the Tingidae resembled those of the Cimicoidea and were of a different type to those of Piesmidae. Following this, Southwood has shown that there are in fact two well-marked egg types in terrestrial Heteroptera: that characteristic of the Trichophora and Aradoidea and that of the Reduviidae, Phymatidae, Tingidae and Cimicoidea. Enicocephalid eggs, as described by Carayon[11], appear unique among the land bugs. The Trichophora and Aradoidea also agree in the possession of a similar type of egg burster, while hatching spines or ridges occur in all groups.

(6) Southwood has found that the two types of accessory salivary glands described in the Heteroptera by Baptist[12] also support these groups. These structures in Piesmidae and Aradoidea resemble those found by Baptist in the Pentatomidae, Coreidae, Neididae, Lygaeidae and Pyrrhocoridae.

It is proposed to erect two groups within Geocorisae, basing them nomenclatorially on genera and thus following Evans's[13] precedent in Homoptera.

Pentatomomorpha: male genitalia of Pentatomoid form or related thereto; ventral trichobothria (or multiple setose areas) present; hind-wings with radius and media distally separated and subcosta never well developed; fore-wings without a costal fracture; spermatheca single, median, usually with a spermathecal duct, muscular pump and an apical sperm storage bulb; eggs with micropylar processes, these consisting of a central canal (for sperm passage) surrounded by a spongy or porous layer (for respiration); operculum usually absent, but when present without deep follicular pits and not differing greatly in structure from the rest of the chorion; eggs probably never embedded into plant tissue at oviposition; egg burster a single structure situated on the vertex of the embryonic cuticle; accessory salivary glands of tubular type.

Cimicomorpha: male genitalia of Reduvioid form or related thereto; ventral trichobothria absent; hind-wings with radius and media distally fused and subcosta often well developed; fore-wings usually with a costal fracture; true spermathecæ absent in Cimicoid families but in Reduvioidea and Tingidae they are paired, laterally placed, usually very thin cuticular sacs, without a pumping apparatus and probably not homologous with the median spermatheca of Pentatomorpha; eggs with micropylar apparatus consisting of canals running in the rim of the chorion surrounding the operculum, which is always present; as shown by Beament[14], micropylar canals of two types, true micropyles (for sperm passage) and pseudomicropyles (for respiration), but one type may be absent; operculum strongly differentiated from rest of chorion, with deep follicular pits; eggs often inserted into plant tissue; median egg burster absent; accessory salivary glands of vesicular type.

The Pentatomorpha contain Pentatomoidea, Coreoidea, Lygaeoidea (= Neidoidea Reuter), Aradoidea, Piesmidae and probably Saldoidea (Saldidae and Leptopodidae), but the last-named superfamily is certainly far from the main Pentatomorpha stem. The Cimicomorpha contains Reduvioidea, Tingidae, Cimicoidea and Joppeicidae. We follow Blöte[15] in considering Scotomedidae (= Velocipedidae) a subfamily of Nabidae, and Carayon[16] in placing this family in Cimicoidea. Dipsocoroidea are probably allied to the Cimicomorpha. Enicocephalidae are apparently Geocorisae, but the hind-wing venation suggests a distant relationship with Hydrocorisae; they are, however, being studied elsewhere. Lack of material has precluded any study of Leotichidae.

From our evidence it seems that certain families sometimes treated as Geocorisae must be removed from this series: Gelastocoridae and Ochteridae are Hydrocorisae. Hence, although recently adopted by Poisson[17], the series Telmatobia of Esaki and China[18] must be abandoned, and this already has been done by China[3]. The placing of Mesovelidae and Hebridae in the Amphibicorisae, as done by most authors, is supported by the present evidence.

Some families or individual genera do not possess all the basic characters of either series: many have reduced venation (for example, Dipsocoroidea) or are apterous (for example, Cimicidae, Polyctenidae); a true spermatheca is absent in *Aneurus* (Aradoidea); ventral trichobothria are lacking in Saldoidea.

For details of the internal anatomy of Cimicoidea and other matters we are indebted to Dr. J. Carayon, Entomologie Agricole Coloniale, Paris.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, July 12

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. C. Kittel (University of California): "Microwave Experiments in the Physics of Solids".*

Monday, July 12—Friday, July 16

UNIVERSITY OF LIVERPOOL (in the Department of Zoology, The University, Liverpool)—Symposium on "The Comparative Endocrinology of Vertebrates".

Monday, July 12—Saturday, July 17

SOCIETY OF CHEMICAL INDUSTRY (at Liverpool)—73rd Annual Meeting.

Tuesday, July 13—Saturday, July 17

PHYSICAL SOCIETY (joint conference with BRISTOL UNIVERSITY and the INSTITUTE OF PHYSICS, at the University, Bristol)—"Physics of the Solid State".

UNIVERSITY OF GLASGOW (in conjunction with the INTERNATIONAL UNION OF PURE AND APPLIED PHYSICS and UNESCO, at the University)—Conference on "Experimental and Theoretical Nuclear Physics". Chairman: Prof. P. I. Dee, F.R.S.

Thursday, July 15—Saturday, July 17

ROYAL METEOROLOGICAL SOCIETY (in the Department of Natural Philosophy, The University, Drummond Street, Edinburgh)—Summer Meeting.*

Friday, July 16

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, Queen's University, Belfast), at 11 a.m.—Scientific Papers.

NATIONAL INSTITUTE OF AGRICULTURAL BOTANY (at Huntingdon Road, Cambridge), at 2.15 p.m.—Annual General Meeting.

Friday, July 16—Wednesday, July 21

JOINT COMMISSION ON ELECTRON MICROSCOPY INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1)—International Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH DEMONSTRATOR IN PHYSICS—The Registrar, University College, Leicester (July 16).

AGRICULTURAL ECONOMIST (graduate, preferably with qualifications in economics and horticulture or agriculture)—The Registrar, Wye College, near Ashford, Kent (July 17).

ASSISTANT LECTURER (preferably with some experience in microbiology or plant biochemistry) in BOTANY—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (July 17).

FARM DEMONSTRATOR (with a degree in agriculture and farming experience), for duties which will include practical instruction on the University Farm to undergraduate and postgraduate students—The Secretary, School of Agriculture, Cambridge (July 17).

RESEARCH FELLOW IN PURE MATHEMATICS—The Registrar, The University, Edgbaston, Birmingham (July 17).

DEMONSTRATOR (Grade III) IN PHYSIOLOGY—The Registrar and Secretary, The University, Bristol (July 19).

SCIENTIFIC OFFICER (honours graduate, and preferably with postgraduate experience in genetics) AT THE PLANT BREEDING STATION—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (July 19).

W. T. HENLEY FELLOW (with a good degree in electrical engineering or physics) for research work in electrical engineering—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (July 19).

ASSISTANT LECTURER IN GEOLOGY—The Secretary, Queen's University Belfast (July 20).

LECTURER (Grade II) IN ZOOLOGY, at University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 21).

RESEARCH ZOOLOGIST (with an honours degree in zoology), to work on the pests of sugar beet—The Secretary, School of Agriculture, Cambridge (July 24).

SCIENTIST, Grade III (with a good honours degree in chemistry or physics), IN THE COAL SURVEY LABORATORY, Leeds—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1 quoting TT/800 (July 28).

LECTURER IN CRYSTALLOGRAPHY in the Department of Geology, LECTURER IN MATHEMATICS, and a LECTURER (preferably with some experience in plant design and operation) IN CHEMICAL ENGINEERING, at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, July 30).

LECTURERS (with a good honours degree in electrical engineering) IN ELECTRICAL ENGINEERING—Head of the Electrical Engineering Department, City and Guilds College, London, S.W.7 (July 30).

ASSISTANT LECTURER (preferably with a special interest and qualifications in parasitology) IN AGRICULTURAL ZOOLOGY—The Registrar, The University, Leeds (July 31).

ASSISTANT LECTURER (with an honours degree in agricultural chemistry or chemistry) IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Reading (July 31).

ASSISTANT (with an honours degree in history or archæology, and prepared to take a special interest in prehistoric archæology) IN THE HUNTERIAN MUSEUM—The Secretary of University Court, The University, Glasgow (July 31).

CHAIR OF CHEMISTRY—The Secretary, The University, Aberdeen (July 31).

LECTURER IN ASTRONOMY—The Secretary, The University, Edinburgh (July 31).

LECTURER IN THE DEPARTMENT OF BOTANY at the University of Natal, Pietermaritzburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, July 31).

PROFESSOR OF GEOPHYSICS—The Director, Institute of Astronomy, Helwan, Egypt (July 31).

* RESEARCH ASSOCIATE (with a good honours degree and some research experience) IN THE LUMINESCENCE LABORATORY of the Department of Physics—The Secretary, The University, Birmingham 15 (July 31).

SENIOR RESEARCH OFFICER (with a university honours degree in fuel technology, or equivalent qualifications, and research experience in fuel technology) IN THE COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, to investigate ash deposition and clinkering phenomena in connexion with the combustion of Australian coals—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/107 (July 31).

LECTURER (preferably with special qualifications in plant morphology) IN BOTANY, at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Armidale, August 2).

CHAIR OF PATHOLOGY and CHAIR OF BACTERIOLOGY, at University College, Ibadan, Nigeria—The Secretary, Senate Committee for Higher Education in the Colonies, Senate House, London, W.C.1 (August 3).

LECTURER IN PLANT PHYSIOLOGY at Auckland University College—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Auckland, August 10).

ASSISTANT LECTURERS (with a special honours degree in the relevant subject) IN BOTANY, GEOLOGY, PHYSICS and PHILOSOPHY—The Secretary, Bedford College, Regent's Park, London, N.W.1 (August 27).

PLANT PATHOLOGIST (with a good degree in botany, including mycology, and preferably with postgraduate research experience or equivalent training in plant pathology or mycology), for research on fungal diseases of hops and fruit—The Secretary, East Malling Research Station, near Maidstone, Kent (September 1).

ANGLO-IRANIAN OIL COMPANY STUDENT for the study of gaseous reactions in the Chemistry Department—The Registrar, Imperial College, London, S.W.7.

ASSISTANT ENTOMOLOGIST, Senior Scientific Officer or Scientific Officer grade, in the Bee Research Department, for work on bee breeding and the pollination of crops—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

ASSISTANT EXPERIMENTAL OFFICERS (2) (with a pass degree in science, H.N.C., or equivalent qualification) in the Department of Scientific and Industrial Research, Intelligence Division, for abstracting and technical information work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A113/54A.

DEMONSTRATOR IN BOTANY—The Registrar, Wye College (University of London), near Ashford, Kent.

ENGINEERS and PHYSICISTS, Senior Scientific Officer and Scientific Officer grades (with an appropriate first- or second-class honours degree, or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52A.

HEAD OF THE CHEMISTRY AND METALLURGY DEPARTMENT, HEAD OF THE ENGINEERING DEPARTMENT, and HEAD OF THE BUILDING DEPARTMENT, at Flintshire Technical College—The Director of Education, County Education Offices, Mold, Flintshire.

HEAD (with sound practical experience and teaching ability) OF THE AGRICULTURAL AND HORTICULTURAL DEPARTMENTS, and FARM MANAGER—The Principal, Studley College, Warwickshire.

INFORMATION OFFICER, Senior Experimental Officer grade (with H.S.C. in science or mathematics, or equivalent) IN THE DEPARTMENT OF ATOMIC ENERGY, Risley, to take charge of a Headquarters Library Information Section—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 620.

LABORATORY TECHNICIAN (with experience in microscopic work and photography) IN THE PHYSIOLOGY DEPARTMENT—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

OFFICER (with a degree in agriculture or botany, or equivalent) FOR OIL AND LEGUME CROPS, and ASSISTANT REGIONAL TRIALS OFFICERS (2) (with a degree in botany or agriculture, or equivalent), to conduct trials on plant breeders' materials at a northern and an eastern sub-station—The Secretary, National Institute for Agricultural Botany, Huntingdon Road, Cambridge.

PHYSICIST (with an honours degree in physics) to carry out fundamental investigations into new methods of casting steel by continuous processes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

RADIOCHEMIST, Principal Scientific Officer or Senior Scientific Officer grade (with a first- or second-class honours degree in chemistry, and some years research experience on the analysis and assessment of radioactive substances) for fundamental research work on radioactive materials—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 154/WGE/2.

Senior Scientific Officer (with a first- or second-class honours degree in physics or physical chemistry, or equivalent qualifications, and several years postgraduate experience), to supervise and participate in the activities of a group investigating application of engineering technology to the manufacture of explosive components—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 107/WGE/2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institution of Professional Civil Servants. Annual Report for the year 1953. Pp. 40. (London: Institution of Professional Civil Servants, 1953.) [145

National Coal Board: Scientific Department. Proceedings of a Colloquium on the Hydraulic Transport of Coal, held by The National Coal Board in London on November 5th and 6th 1952. Pp. vi+75. (London: National Coal Board, 1954.) [145

Institution of Metallurgists. The Microscopy of Metals: Lectures delivered at the Institution's Refresher Course 1953. Pp. 132. (London: Institution of Metallurgists, 1954.) 15*s*. 6*d*. [145

Department of Scientific and Industrial Research. Research on Food Preservation in the United Kingdom. Pp. iv+56. (London: H.M. Stationery Office, 1954.) 2*s*. net. [145

Industrial Diamond Trade Index and Yearbook for 1954. Pp. 122. (Hammersmith, London: N.A.G. Press, Ltd., 1954.) 3*s*. 6*d*. [145

Department of Scientific and Industrial Research. Report of the Hydraulics Research Board, with the Report of the Director of Hydraulics Research for the year 1953. Pp. vi+52+8 plates and 4 maps. (London: H.M. Stationery Office, 1954.) 1*s*. 6*d*. net.

Publications of the Thoresby Society. Fourth Report, 1953: Kirkstall Abbey Excavation. Pp. 51–66+plates 7 and 8. (Leeds: Thoresby Society, 1954.) 1*s*. [145

Disposal of Waste Waters from Industrial Premises. (FBI Handbook.) Pp. iv+36. (London: Federation of British Industries, 1954.) 2*s*. 6*d*. [185

Institute of Physics. Thirty-third Annual Report. Pp. 24. (London: Institute of Physics, 1954.) [215

Royal Sanitary Institute. Annual Report of the Council for the year 1953. Pp. 26. (London: Royal Sanitary Institute, 1954.) [215

Ministry of Health. Memorandum on Measures for the Control of Mosquito Nuisances in Great Britain. Revised 1954. Pp. 38 (2 plates). (London: H.M. Stationery Office, 1954.) 1*s*. 3*d*. net. [215

Philosophical Transactions of the Royal Society of London. Series A—Mathematical and Physical Sciences. No. 916, Vol. 246, 13 May 1954: Uniform Polyhedra. By Prof. H. S. M. Coxeter, M. S. Longuet-Higgins and J. C. P. Miller. Pp. 401–450+6 plates. (London: Cambridge University Press, 1954.) 25*s*. [215

World Calendar News—Bulletin of the British Section of the World Calendar Association International. No. 1, May 1954. Pp. 4. (London: World Calendar Association, British Section, 1954.) [215

Department of Scientific and Industrial Research. Report of the Road Research Board, with the Report of the Director of Road Research for the year 1953. Pp. vi+90+15 plates. (London: H.M. Stationery Office, 1954.) 5*s*. net. [255

British Drug Houses, Limited. Report and Accounts, 1953. Pp. 16. (London: British Drug Houses, Ltd., 1954.) [265

The Staffing of Grammar Schools: a Survey of the Staffing of 66 Grammar Schools in the North West of England, with special reference to the Teaching of Arts, Science and Mathematics. By W. E. Egner and A. Young. Pp. 20. (Liverpool: At the University Press, 1954.) 2*s*. [265

Ministry of Agriculture and Fisheries. Memoirs of the Soil Survey of Great Britain—England and Wales. The Soils of the Wem District of Shropshire (Sheet 138). By E. Crompton and D. A. Osmond. Pp. vii+80+4 plates. (London: H.M. Stationery Office, 1954.) 10*s*. 6*d*. net. [285

Memorandum by the National Smoke Abatement Society to the Committee on Air Pollution. Pp. 16. (London: National Smoke Abatement Society, 1954.) 1*s*. [285

International Committee for Bird Preservation—British Section. Annual Report for 1953. Pp. 48+2 plates. (London: International Committee for Bird Preservation, c/o British Museum (Natural History), 1945.) 2*s*. [285

Council for the Preservation of Rural England. Twenty-Eighth Annual Report 1953–54. (Vol. 16, No. 2.) Pp. 64+4 plates. (London: Council for the Preservation of Rural England, 1954.) [285

The American Outlook in Foreign Affairs. By The Rt. Hon. Sir Oliver Franks, G.C.M.G., K.C.B., C.B.E. (Twelfth Montague Burton Lecture on International Relations.) Pp. 14. (Leeds: University of Leeds, 1954.) 6*d*. [315

Report of the Rothamsted Experimental Station for 1953. Pp. 228. (Harpenden: Rothamsted Experimental Station, 1954.) 7*s*. 6*d*. [315

Other Countries

Geological Survey of South Africa. Annexure to Volume 56: Gondwanaland and the Distribution of Early Reptiles. By S. H. Haughton. (Alex L. du Toit Memorial Lecture—No. 3.) Pp. 30. (Johannesburg: Geological Society of South Africa; South African Association for the Advancement of Science; South African Geographical Society, 1954.) [145

Union of South Africa. Department of Commerce and Industries: Division of Fisheries. Twenty-Third Annual Report, for the year ended December, 1951. By Dr. J. M. Marchand. Pp. 182. (Pretoria: Government Printer, 1953.) [145

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 85: Technological Reports on Standard Indian Cottons, 1953. Pp. iv+98. (Bombay: Vakil and Sons, Ltd., 1953.) 2 rupees. [185

Brookhaven Symposia in Biology No. 6: Abnormal and Pathologies Plant Growth. (Report of Symposium held August 3 to 5, 1953. (BNL 258 (C–19)). Pp. vii+303. (Upton, N.Y.: Brookhaven Nation Laboratory, 1954.) 2.10 dollars. [18

Transactions of the American Philosophical Society. New Series Vol. 14, Part 1: The Monguors of the Kansu-Tibetan Frontier—The Origin, History, and Social Organization. By Louis M. J. Schran Pp. ii+138. (Philadelphia: American Philosophical Society, 195 2 dollars. [18

New Zealand Forest Service. Information Series No. 16: Brandi the Beeches in Bush and Mill. Pp. 8. Information Series No. 17 Beech Timbers: Properties and Uses of Nothofagus Species. B J. S. Reid. Pp. 36+4 plates. (Wellington: Government Printer 1953.) [18

Nigeria. An Outline of Nigerian Vegetation. By R. W. J. Keay Pp. 55. (Ibadan: Government Printer; London: Crown Agents fo the Colonies, 1953.) 5*s*. net. [18

Smithsonian Miscellaneous Collections. Vol. 122, No. 10: Tw Silicified Carboniferous Trilobites from West Texas. By Harry B Whittington. Pp. ii+16+3 plates. (Publication 4146.) Vol. 12 No. 13: Washington, D.C., Precipitation of 1953 and 1954. By C. G Abbot. Pp. 4. (Publication 4170.) (Washington, D.C.: Smithsonia Institution, 1954.) [18

Colony of Trinidad and Tobago. Forest Department. Annua Report for the year 1952. Pp. 32. (Trinidad: Government Printin Office, 1954.) 36 cents. [18

Commonwealth Observatory, Canberra. Report of the Common wealth Astronomer for the year 1953. Pp. 6. (Canberra: Governmen Printer, 1945.) [18

Bulletin of the Bingham Oceanographic Collection, Peabod Museum of Natural History, Yale University. Vol. 14, Article 3: Th Character and Significance of Sound Production among Fishes of th Western North Atlantic. By Marie Poland Fish. Pp. 109. (New Haven Conn.: Peabody Museum of Natural History, Yale University, 1954. 1.65 dollars. [21

United States Department of Commerce: National Bureau o Standards. Applied Mathematics Series No. 40: Table of Secants an Cosecants to Nine Significant Figures at Hundredths of a Degree Pp. vi+46. (Washington, D.C.: Government Printing Office, 1954. 35 cents. [21

University of Illinois Engineering Experiment Station. Reprin Series No. 53: Progress Reports of Investigations of Railroad Rai and Joint Bars. By R. E. Cramer and R. S. Jensen. Pp. 40. 30 cent Bulletin Series No. 420: The Influence of Temperature and Rate o Strain on the Properties of Metals in Torsion. By Clyde E. Work an Prof. Thomas J. Dolan. Pp. 109. 1 dollar. Bulletin Series No. 421 Almost Sinusoidal Oscillations in Nonlinear Systems, Part 3: Transien Phenomena. By J. S. Schaffner. Pp. 39. 40 cents. Bulletin No. 422 The Properties of Feldspars and their use in Whitewares. By Joseph C Kyonka and Prof. Ralph L. Cook. Pp. 34. 60 cents. Bulletin No. 423 Engineering Properties of Chicago Subsoils. By Prof. Ralph B. Pec and William C. Reed. Pp. 62. 1 dollar. (Urbana, Ill.: University o Illinois, 1953 and 1954.) [21

Conseil Permanent International pour l'Exploration de la Mer Rapports et Procès-Verbaux des Réunions. Vol. 135: 1ème Partie—Procès-Verbaux (Septembre–Octobre, 1953). 2ème Partie—Rappor Administratif (1952). Pp. 94. (Copenhague: Andr. Fred. Host e Fils, 1954.) 14 kronor. [21

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 3 No. 4: A Half Century of Progress Against Tuberculosis. Pp. 1 (New York: Metropolitan Life Insurance Company, 1954.) [21

United States Department of Agriculture. Leaflet No. 195: Mea worms. Pp. 6. 5 cents. Circular No. 937: Ecology of the Sier Nevada Gooseberry in Relation to Blister Rust Control. By Clarenc R. Quick. Pp. 30. 15 cents. (Washington, D.C.: Governmen Printing Office, 1954.) [21

FAO Nutritional Studies No. 11: Food Composition Tables Minerals and Vitamins. (A report prepared by Charlotte Chatfiel Nutrition Division.) Pp. 118. (Rome: Food and Agriculture Organiza tion of the United Nations, 1954.) 1 dollar; 5*s*. [25

World Health Organization. Technical Report Series No. 78 Expert Committee on Rheumatic Diseases—First Report. Pp. 2 (Geneva: World Health Organization; London: H.M. Stationer Office, 1954.) 1 Swiss franc; 1*s*. 9*d*. net.; 0.25 dollars. [25

Nigeria. Annual Report on the Agricultural Department, Nigeria for the year 1951–52. Pp. v+76. (Lagos: Government Printer London: Crown Agents for the Colonies, 1954.) 9*d*. net. [26

World Health Organization. Technical Report Series No. 82 Expert Committee on Rabies—Second Report. Pp. 28. (Geneva World Health Organization; London: H.M. Stationery Office, 1954 1 Swiss franc; 1*s*. 9*d*. net.; 0.25 dollars. [26

Fonds National de la Recherche Scientifique. Vingt-sixième Rappor Annuel, 1952–1953. Pp. 231. (Bruxelles: Fonds National de la Re cherche Scientifique, 1953.) [26

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